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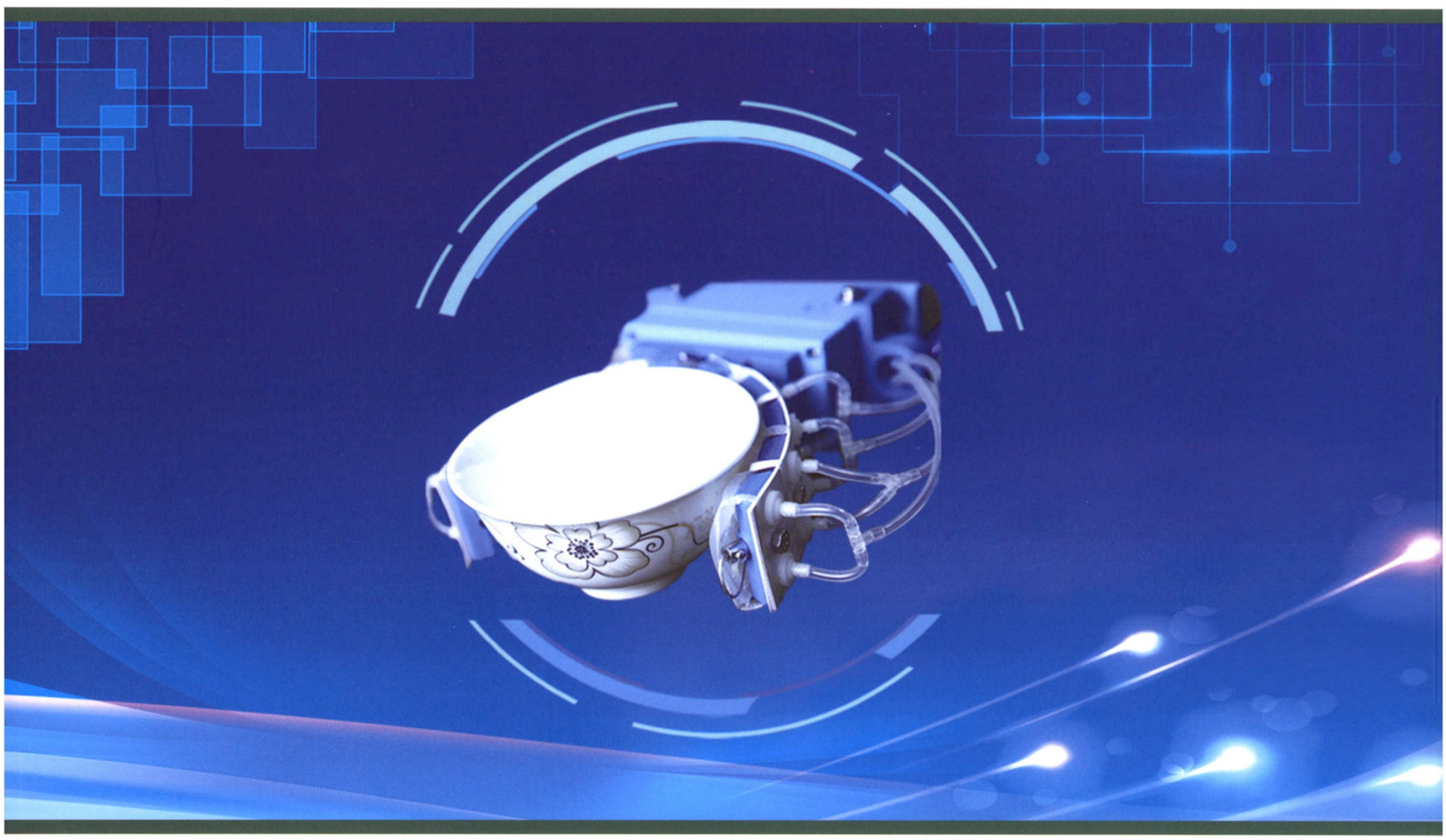

DOI: 10.1186/s10033-018-0290-x

A New Grasping Mode Based on a Sucked-type Underactuated Hand

Pei-Chen Wu, Nan Lin, Ting Lei, Qian Cheng, Jin-Ze Wu and Xiao-Ping Chen

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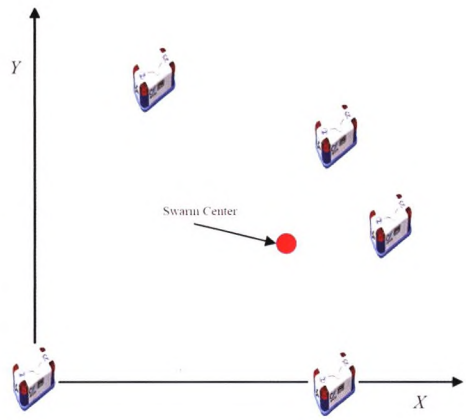
Review

DOI: 10.1186/s10033-018-0310-x

Udwadia-Kalaba Equation for Constrained Mechanical Systems: Formulation and Applications. Xiao-Min Zhao • Ye-Hwa Chen • Han Zhao • Fang-Fang Dong

Abstract: There are many achievements in the field of analytical mechanics, such as Lagrange Equation, Hamilton's Principle, Kane's Equation. Compared to Newton-Euler mechanics, analytical mechanics have a wider range of applications and the formulation procedures are more mathematical. However, all existing methods of analytical mechanics were proposed based on some auxiliary variables. In this review, a novel analytical mechanics approach without the aid of Lagrange's multiplier, projection, or any quasi or auxiliary variables is introduced for the central problem of mechanical systems. Since this approach was firstly proposed by Udwadia and Kalaba, it was called Udwadia-Kalaba Equation. It is a representation for the explicit expression of the equations of motion for constrained mechanical systems. It can be derived via the Gauss's principle, d'Alembert's principle or extended d'Alembert's principle. It is applicable to both holonomic and nonholonomic equality constraints, as long as they are linear with respect to the accelerations or reducible to be that form. As a result, the Udwadia-Kalaba Equation can be applied to a very broad class of mechanical systems. This review starts with introducing the background by a brief review of the history of mechanics. After that, the formulation procedure of Udwadia-Kalaba Equation is given. Furthermore, the comparisons of Udwadia-Kalaba Equation with Newton-Euler Equation, Lagrange Equation and Kane's Equation are made, respectively. At last, three different types of examples are given for demonstrations.

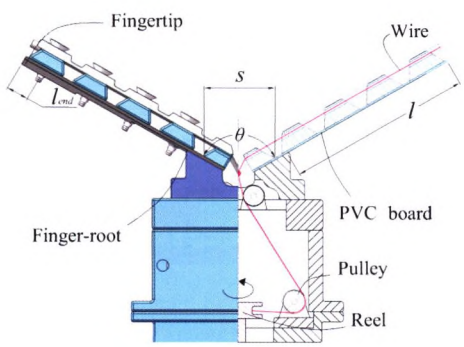


Mechanism and Robotics

DOI: 10.1186/s10033-018-0290-x

A New Grasping Mode Based on a Sucked-type Underactuated Hand. Pei-Chen Wu • Nan Lin • Ting Lei • Qian Cheng • Jin-Ze Wu • Xiao-Ping Chen

Abstract: Robot hands have been developing during the last few decades. There are many mechanical structures and analytical methods for different hands. But many tough problems still limit robot hands to apply in homelike environment. The ability of grasping objects covering a large range of sizes and various shapes is fundamental for a home service robot to serve people better. In this paper, a new grasping mode based on a novel sucked-type underactuated (STU) hand is proposed. By combining the flexibility of soft material and the effect of suction cups, the STU hand can grasp objects with a wide range of sizes, shapes and materials. Moreover, the new grasping mode is suitable for some situations where the force closure is failure. In this paper, we deduce the effective range of sizes of objects which our hand using the new grasping mode can grasp. Thanks to the new grasping mode, the ratio of grasping size between the biggest object and the smallest is beyond 40, which makes it possible for our robot hand to grasp diverse objects in our daily life. For example, the STU hand can grasp a soccer (220 mm diameter, 420 g) and a fountain pen (9 mm diameter, 9 g). What's more, we use the rigid body equilibrium conditions to analysis the force condition. Experiment evaluates the high load capacity, stability of the new grasping mode and displays the versatility of the STU hand. The STU hand has a wide range of applications especially in unstructured environment.



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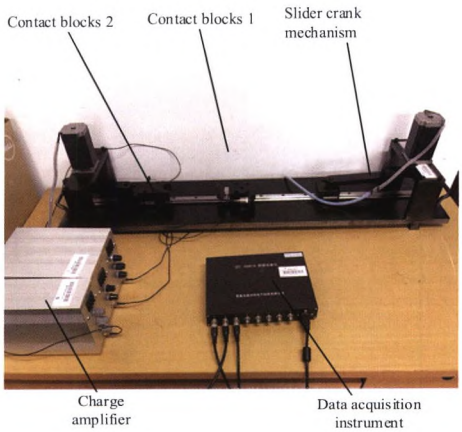
DOI: 10.1186/s10033-018-0308-4

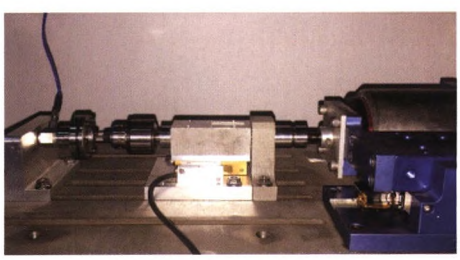
Contact Model of Revolute Joint with Clearance Based on Fractal Theory. Shi-Hua Li • Xue-Yan Han • Jun-Qi Wang • Jing Sun • Fu-Juan Li



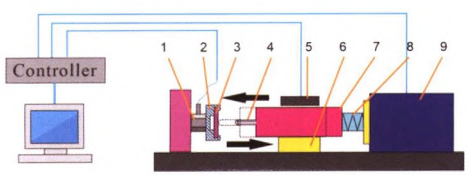
Abstract: The contact stiffness of a mechanical bonding surface is an important parameter in determining the normal and radial contact force. To improve the calculation accuracy of the contact force model, the surface roughness of the bonding surface and the energy loss that necessarily occurs during the impact process should be considered comprehensively. To study the normal contact force of a revolute joint with clearance more accurately in the case of dry friction, a nonlinear stiffness coefficient model considering the surface roughness was established based on fractal theory, which considers the elastic, elastic-plastic, and plastic deformations of the asperities of the contact surface during the contact process. On this basis, a modified nonlinear spring damping model was established based on the Lankarani-Nikravesh contact force model. The laws influencing the surface roughness, recovery coefficient, initial velocity, and clearance size on the impact force were revealed, and were compared with the Lankarani-Nikravesh model and a hybrid model using MATLAB. The maximum impact force was obtained using a modified contact force model under different initial velocities, different clearances, and different degrees of surface roughness, and the calculated results were then compared with the experiment results. This study indicates that the modified model can be used more widely than other models, and is suitable for both large and small clearances. In particular, the modified model is more accurate when calculating the contact force of a revolute joint with a small clearance.

DOI: 10.1186/s10033-018-0305-7

Effect of Cycling Low Velocity Impact on Mechanical and Wear Properties of CFRP Laminate Composites. Yang Sun • Zhen-Bing Cai • Song-Bo Wu • Jian-Hua Liu • Jia-Xin Yu



(a) Structure of the impact wear equipment



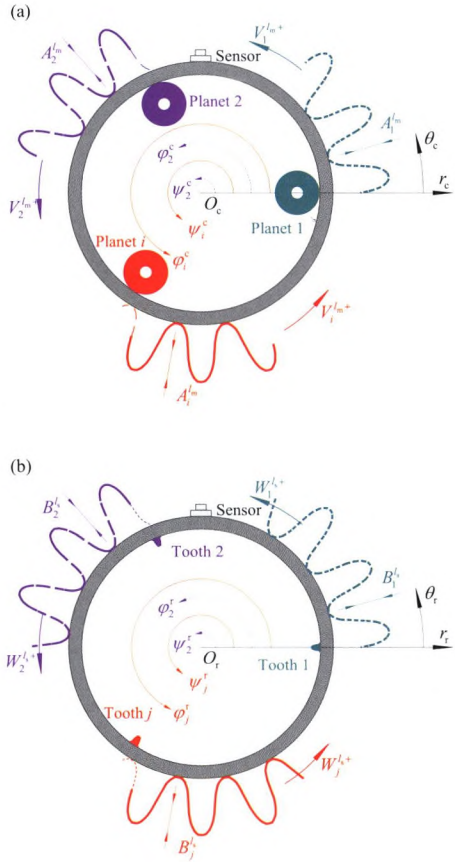
(b) Concept sketch of the impact wear equipment.

Abstract: The mechanical and wear properties of CFRP laminate were investigated using a method of cycling low velocity impact, to study the trend and mechanism of impact resistance of the CFRP laminate under repeated impact during its service process. The interface responses of CFRP laminate under different impact kinetic energy during the cycling impact process were studied were studied experimentally, such as impact contact duration, deformation and energy absorption. The worn surface morphologies were observed through optical microscopy (OM) and a 3-D surface profiler and the cross-sectional morphologies were observed through SEM to investigate the mechanism of impact material damage. Based on a single-degree-of-freedom damping vibration model, the normal contact stiffness and contact damping of the material in different wear stages were calculated. It shows the failure process of CFRP laminate damaged by accumulated absorption energy under the cycling impact of different initial kinetic energy. The results indicate that the stiffness and damping coefficients will change at different impact velocities or cycle numbers. The damage mechanism of CFRP laminates under cycling low kinetic energy is delamination. After repeated experiments, it was found that there was a threshold value for the accumulated absorption energy before the failure of the CFRP laminate.

DOI: 10.1186/s10033-018-0300-z

Investigation on Mesh and Sideband Vibrations of Helical Planetary Ring Gear Using Structure, Force and Deformation Symmetries. Shi-Yu Wang • Chanannipat Meesap

Abstract: Time-variant excitations in planetary gears can cause excessive noise and vibration and even damage the system on a permanent-basis, but the existing studies pay little attention to the relationships between the structure, excitations, and deformation symmetries. This paper focuses on the helical planetary ring gear subjected to mesh and planet-pass excitations. Based on symmetries, this paper proposes dual-frequency approaches to capture the mesh and sideband vibrations. The transition effect between ring gear tooth and planet is introduced to address the typical excitations and vibrations. The phasing effect of ring gear tooth and planet on various deformations is formulated. The inherent connections between the two types of vibrations are identified. The results imply that the mesh and sideband vibrations share identical exciting rules due to the relation between the engaged components such that the wavenumber and modulating signal order both equal the linear combination of gear tooth and planet counts. The results cover the in-plane bending and extensional, out-of-plane bending and torsional deformations. Main findings are demonstrated by the finite element method and verified by strict comparisons against the open literature. The analytical expressions lead to a simple design strategy to suppress elastic vibration, also they can determine whether the sideband is caused by component fault or only by elastic vibration. Moreover, the methods can be extended to hollow sun or face gears because little restriction is imposed during the analysis.

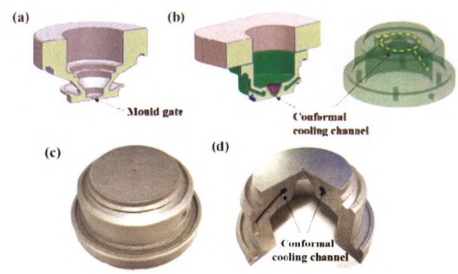


Intelligent Manufacturing Technology

DOI: 10.1186/s10033-018-0312-8

Corrosion Behavior of the S136 Mold Steel Fabricated by Selective Laser Melting. Shi-Feng Wen • Xian-Tai Ji • Yan Zhou • Chang-Jun Han • Qing-Song Wei • Yu-Sheng Shi

Abstract: The selective laser melting (SLM) method has a great potential for fabricating injection mold with complex structure. However, the microstructure and performance of the SLM molds show significantly different from those manufactured by traditional technologies. In this study, the microstructure, hardness and especially corrosion behavior of the samples fabricated by SLM and casting were investigated. The XRD results exhibit that the γ-Fe phase is only obtained in the SLM parts, and the α-Fe peak slightly moves to low diffraction angle compared with casting counterparts. Due to the rapid cooling rate, the SLM samples have fine cellular microstructures while the casting ones have coarse grains with obvious elements segregation. Besides, the SLM samples show anisotropy, hardness of side view and top view are 48.73 and 50.31 HRC respectively, which are 20% higher than that of casting ones. Corrosion results show that the SLM samples have the better anti-corrosion resistance (in a 6% $FeCl_3$ solution for 48 h) but the deeper corrosion pits than casting ones. Finally, the performance of the SLM molds could meet the requirement of injecting production. Moreover, the molds especially present a significant decrease (20%) of cooling time and increases of cooling uniformity due to the customized conformal cooling channels.



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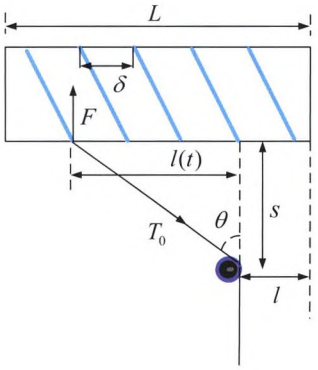
DOI: 10.1186/s10033-018-0304-8

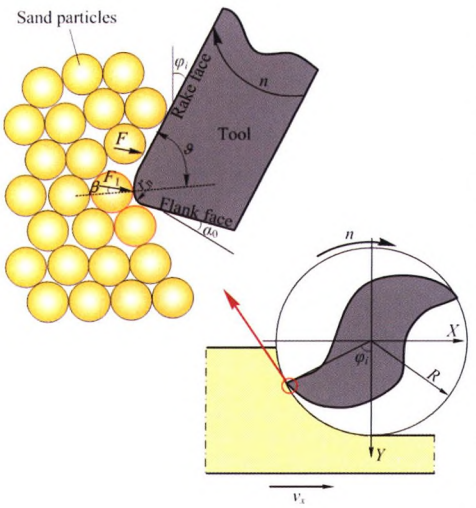
Design and Analysis of a Novel Tension Control Method for Winding Machine. Xiao-Ming Xu • Wu-Xiang Zhang • Xi-Lun Ding • Ming Zhang • Shi-Hou Wei



Abstract: Filament winding has emerged as the main process for carbon fiber reinforced plastic (CFRP) fabrication, and tension control plays a key role in enhancing the quality of the winding products. With the continuous improvement of product quality and efficiency, the precision of the tension control system is constantly improving. In this paper, a novel tension control method is proposed, which can regulate the fiber tension and transport speed of the winding process by governing the outputs of three different driven rollers (the torque of the unwind roll, the torque of the magnetic powder brake roller, and the speed of the master speed roller) in three levels. The mechanical structures and dynamic models of the driven rollers and idle rollers are established by considering the time-varying features of the roller radius and inertia. Moreover, the influence of parameters and speed variation on fiber tension is investigated using the increment model. Subsequently, the control method is proposed by applying fiber tension in three levels according to the features of the three driven rollers. An adaptive fuzzy controller is designed for tuning the PID parameters online to control the speed of the master speed roller. Simulation is conducted for verifying the performance and stability of the proposed tension control method by comparing with those of the conventional PID control method. The result reveals that the proposed method outperforms the conventional method. Finally, an experimental platform is constructed, and the proposed system is applied to a winding machine. The performance and stability of the tension control system are demonstrated via a series of experiments using carbon fiber under different reference speeds and tensions. This paper proposes a novel tension control method to regulate the fiber tension and transport speed.

DOI: 10.1186/s10033-018-0306-6

A Model for Predicting Dynamic Cutting Forces in Sand Mould Milling with Orthogonal Cutting. Zhong-De Shan • Fu-Xian Zhu



Abstract: Cutting force is one of the research hotspots in direct sand mould milling because the cutting force directly affects the machining quality and tool wear. Unlike metals, sand mould is a heterogeneous discrete deposition material. There is still a lack of theoretical research on the cutting force. In order to realize the prediction and control of the cutting force in the sand mould milling process, an analytical model of cutting force is proposed based on the unequal division shear zone model of orthogonal cutting. The deformation velocity relations of the chip within the orthogonal cutting shear zone are analyzed first. According to the flow behavior of granular, the unequal division shear zone model of sand mould is presented, in which the governing equations of shear strain rate, strain and velocity are established. The constitutive relationship of quasi-solid-liquid transition is introduced to build the 2D constitutive equation and deduce the cutting stress in the mould shear zone. According to the cutting geometric relations of up milling with straight cutting edge and the transformation relationship between cutting stress and cutting force, the dynamic cutting forces are predicted for different milling conditions. Compared with the experimental results, the predicted results show good agreement, indicating that the predictive model of cutting force in milling sand mould is validated. Therefore, the proposed model can provide the theoretical guidance for cutting force control in high efficiency milling sand mould.

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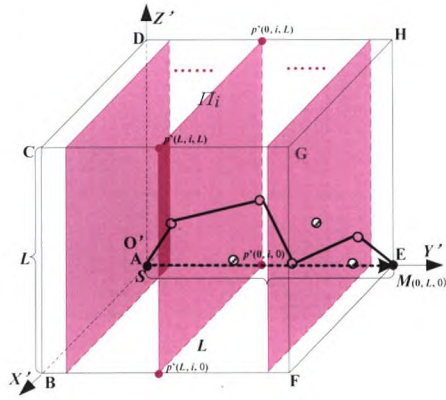
DOI: 10.1186/s10033-018-0311-9

Improved Ant Colony-Genetic Algorithm for Information Transmission Path Optimization in Remanufacturing Service System. Lei Wang • Xu-Hui Xia • Jian-Hua Cao • Xiang Liu • Jun-Wei Liu

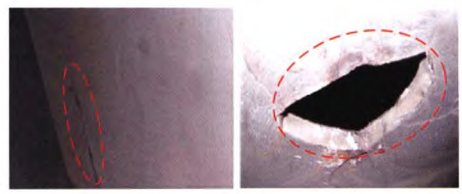
Abstract: The information transmission path optimization (ITPO) can often affect the efficiency and accuracy of remanufacturing service. However, there is a greater degree of uncertainty and complexity in information transmission of remanufacturing service system, which leads to a critical need for designing planning models to deal with this added uncertainty and complexity. In this paper, a three-dimensional (3D) model of remanufacturing service information network for information transmission is developed, which combines the physic coordinate and the transmitted properties of all the devices in the remanufacturing service system. In order to solve the basic ITPO in the 3D model, an improved 3D ant colony algorithm (Improved AC) was put forward. Moreover, to further improve the operation efficiency of the algorithm, an improved ant colony-genetic algorithm (AC-GA) that combines the improved AC and genetic algorithm was developed. In addition, by taking the transmission of remanufacturing service demand information of certain roller as example, the effectiveness of AC-GA algorithm was analyzed and compared with that of improved AC, and the results demonstrated that AC-GA algorithm was superior to AC algorithm in aspects of information transmission delay, information transmission cost, and rate of information loss.



DOI: 10.1186/s10033-018-0295-5

Natural Characteristic of Thin-Wall Pipe under Uniformly Distributed Pressure. Chao-Feng Li • Qian-Sheng Tang • Hou-Xin She • Bang-Chun Wen

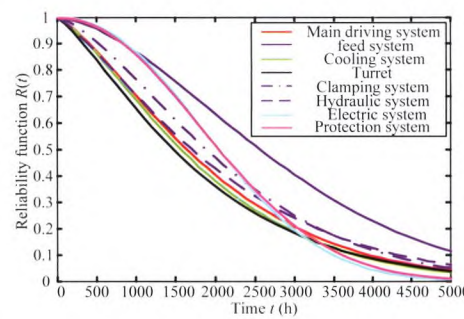
Abstract: Natural characteristics of thin-wall pipe of the compressor under uniformly distributed pressure were presented in this paper based on a cylindrical shell model. In the traditional method, the beam model was usually used to analyze the pipe system. In actual fact, the pipe segment of the compressor was always broken in the form of a long crack or a partial hole and the phenomenon was hardly explained by beam model. According to the structure characteristic of compressor pipe segment, whose radius is large and thickness is little, shell model shows the advantage in this kind of pipe problem. Based on Sanders' shell theory, the vibration differential equation of pipe was established by applying the energy method. The influences of length to radius ratio (L/R), thickness to radius ratio (h/R), circumferential wave number (n) and pressure (q) on the natural frequencies of pipe were analyzed. The study shows: Pressure and structural parameters have a great effect on the natural characteristics of the pipe. Natural frequency increases as the pressure increases, especially for the higher mode. The sensitivity of natural frequency on pressure becomes stronger with h/R ratio increases; when L/R ratio is greater than a certain critical value, the influence of the pressure on natural frequency will no longer be obvious. The value of n corresponding to the minimum natural frequency also depends on the value of pressure. In the end, analysis of the forced vibration of a specific pipeline model was given and the modal shapes were illustrated to understand the break of the pipe. The research here will provide the theory support for the dynamic design of related pressure pipe and further experiment study should be employed.



DOI: 10.1186/s10033-018-0303-9

A Reliability Allocation Method of CNC Lathes Based on Copula Failure Correlation Model. Hao Wang • Yi-Min Zhang • Zhou Yang

Abstract: The current research of reliability allocation of CNC lathes always treat CNC lathes as independent series systems. However, CNC lathes are complex systems in the actual situation. Failure correlation is rarely considered when reliability allocation is conducted. In this paper, drawbacks of reliability model based on failure independence assumption are illustrated, after which, reliability model of CNC lathes considering failure correlation of subsystems is established based on Copula theory, which is an improvement of traditional reliability model of series systems. As the failure time of CNC lathes often obeys Weibull or exponential distribution, Gumbel Copula is selected to build correlation model. After that, a reliability allocation method considering failure correlation is analyzed based on the model established before. Reliability goal is set first and then failure rates are allocated to subsystems according to the allocation vector through solving the correlation model. Reliability allocation is conducted for t=1. A real case of a CNC lathe and a numerical case are presented together to illustrate the advantages of the reliability model established considering failure correlation and the corresponding allocation method. It shows that the model accords to facts and real working condition more, and failure rates allocated to all the subsystems are increased to some extent. This research proposes a reliability allocation method which takes failure correlation among subsystems of CNC lathes into consideration, and costs for design and manufacture could be decreased.



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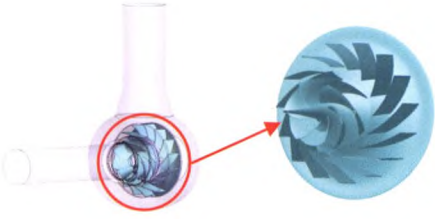
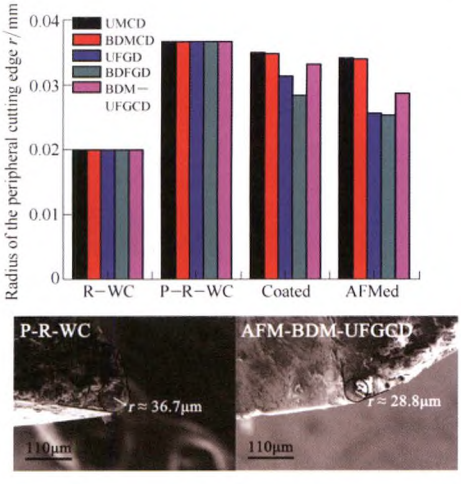


DOI: 10.1186/s10033-018-0302-x

Application of the Modified Inverse Design Method in the Optimization of the Runner Blade of a Mixed-Flow Pump. Ye-Ming Lu • Xiao-Fang Wang • Wei Wang • Fang-Ming Zhou

Abstract: To improve the design speed and reduce the design cost for the previous blade design method, a modified inverse design method is presented. In the new method, after a series of physical and mathematical simplifications, a sail-like constrained area is proposed, which can be used to configure different runner blade shapes. Then, the new method is applied to redesign and optimize the runner blade of the scale core component of the 1400-MW canned nuclear coolant pump in an established multi-optimization system compromising the Computational Fluid Dynamics (CFD) analysis, the Response Surface Methodology (RSM) and the Non-dominated Sorting Genetic Algorithm-II (NSGA-II). After the execution of the optimization procedure, three optimal samples were ultimately obtained. Then, through comparative analysis using the target runner blade, it was found that the maximum efficiency improvement reached 1.6%, while the head improvement was about 10%. Overall, a promising runner blade inverse design method which will benefit the hydraulic design of the mixed-flow pump has been proposed.



DOI: 10.1186/s10033-018-0296-4

Approach for Polishing Diamond Coated Complicated Cutting Tool: Abrasive Flow Machining (AFM). Xin-Chang Wang • Cheng-Chuan Wang • Chang-Ying Wang • Fang-Hong Sun

Abstract: Lower surface roughness and sharper cutting edge are beneficial for improving the machining quality of the cutting tool, while coatings often deteriorate them. Focusing on the diamond coated WC-Co milling cutter, the abrasive flow machining (AFM) is selected for reducing the surface roughness and sharpening the cutting edge. Comparative cutting tests are conducted on different types of coated cutters before and after AFM, as well as uncoated WC-Co one, demonstrating that the boron-doped microcrystalline and undoped fine-grained composite diamond coated cutter after the AFM (AFM-BDM-UFGCD) is a good choice for the finish milling of the 6063 Al alloy in the present case, because it shows favorable machining quality close to the uncoated one, but much prolonged tool lifetime. Besides, compared with the micro-sized diamond films, it is much more convenient and efficient to finish the BDM-UFGCD coated cutter covered by nano-sized diamond grains, and resharpen its cutting edge by the AFM, owing to the lower initial surface roughness and hardness. Moreover, the boron incorporation and micro-sized grains in the underlying layer can enhance the film-substrate adhesion, avoid the rapid film removal in the machining process, and thus maximize the tool life (1040 m, four times more than the uncoated one). In general, the AFM is firstly proposed and discussed for post-processing the diamond coated complicated cutting tools, which is proved to be feasible for improving the cutting performance

DOI: 10.1186/s10033-018-0297-3

Gas Pool Coupled Activating TIG Welding Method with Coupling Arc Electrode. Yong Huang • Rui-Lin Liu • Yan-Zhao Hao

Abstract: Gas pool coupled activating TIG (GPCA-TIG) welding put forward in-house can dramatically enhance weld penetration of TIG welding through introducing active element oxygen to reverse the Marangoni convection flow in the molten pool. In order to further improve the welding productivity, the normal solid tungsten electrode is replaced by a kind of coupling arc electrode. The changes of arc pressure distribution along anode surface and the weld appearance were evaluated. On this basis, the dependences of weld shape characterized with weld depth, width and undercut on the main welding parameters were discussed. The results indicate, the substitution of coupling arc electrode can lead to an obvious decrease of arc pressure. Compared to hollow tungsten electrode and twin tungsten electrodes, the coupling arc electrode is much easier to manufacture and has more compacter structure. Combined with the symmetric distribution of arc pressure in different directions, this electrode has extensive adaptability. In the GPCA-TIG welding with coupling arc electrode, both the substitution of coupling arc electrode and the introduction of outer active gas oxygen can reduce the possibilities of producing humping bead and undercut. Their joint action makes this welding method have the capability of realizing high travel speed and deep penetration welding.

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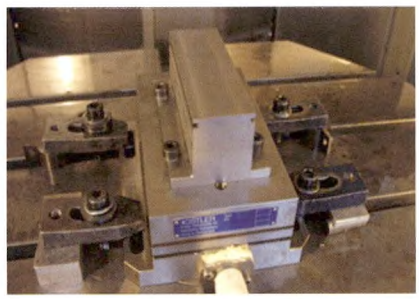
DOI: 10.1186/s10033-018-0298-2

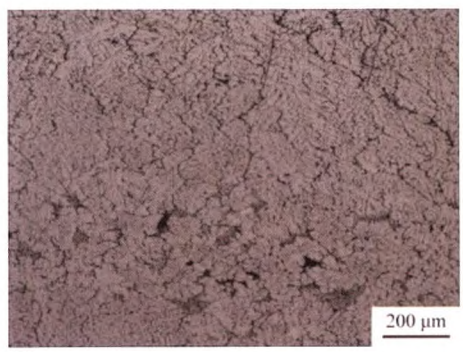
Wear Mechanism of Cemented Carbide Tool in High Speed Milling of Stainless Steel. Guang-Jun Liu • Zhao-Cheng Zhou • Xin Qian • Wei-Hai Pang • Guang-Hui Li • Guang-Yu Tan



Abstract: Adhesion of cutting tool and chip often occurs when machining stainless steels with cemented carbide tools. Wear mechanism of cemented carbide tool in high speed milling of stainless steel 0Cr13Ni4Mo was studied in this work. Machining tests on high speed milling of 0Cr13Ni4Mo with a cemented carbide tool are conducted. The cutting force and cutting temperature are measured. The wear pattern is recorded and analyzed by high-speed camera, scanning electron microscope (SEM) and energy dispersive X-ray spectroscopy (EDS). It is found that adhesive wear was the dominant wear pattern causing tool failure. The process and microcosmic mechanism of the tool's adhesive wear are analyzed and discussed based on the experimental results. It is shown that adhesive wear of the tool occurs due to the wear of coating, the affinity of elements Fe and Co, and the grinding of workpiece materials to the tool material. The process of adhesive wear includes both microcosmic elements diffusion and macroscopic cyclic process of adhesion, tearing and fracture.

DOI: 10.1186/s10033-018-0299-1

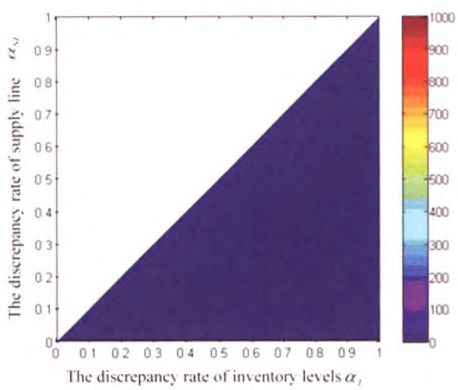
Effect of Oscillation Parameters to Flow Field in the Pool during the Oscillating Twin-Roll Strip Casting Process. Zhi-Qiang Xu • Zhe-Ru Meng • Shun-Hui Xue • De-Quan Zhang • Feng-Shan Du



Abstract: During the oscillating twin-roll strip casting process, the quality of final products is directly influenced by the flow field distribution of molten metal in the pool. The variation in the flow field is caused by oscillating roller benefits, for homogeneous distribution of strip impurity, and decreasing the grain size. Thus, the quality of the strip could be improved. A numerical model was developed using the multiphase flow technology, coupled with heat transfer, fluid flow, solidification, and oscillation. Furthermore, a transient algorithm was adopted for simulating the oscillating twin-roll strip casting process of AlSi9Cu3 and 3104 aluminum alloy. This paper focuses on the flow distribution in the pool, in comparison with the traditional vertical twin-roll strip casting process, while the amplitude or frequency is changing with the definite value of casting velocity, roller diameter, nozzle angle, and the strip thickness. Consequently, the conclusions were experimentally validated by oscillating twin-roll 3104 aluminum alloy strip casting. Vibrating casting technology can change the flow field in the pool by vibration, which can improve the quality of the strip core.

DOI: 10.1186/s10033-018-0309-3

Effect of Ordering Policies on Complex Dynamics Behaviours in a Discrete-Type Manufacturing Industry Supply Chain System. Wen Wang • Wei-Ping Fu



Abstract: The beer game model is a typical paradigm used to study complex dynamics behaviours in production-distribution systems. The model, however, does not accord with current practical supply chain system models in discrete-type manufacturing industry, which are generally composed of retailers, distributors, manufacturers with internal supply chain, and suppliers. To describe how ordering policies influence the complex dynamics behaviour modes and operating cost in a general discrete-type manufacturing industry supply chain system, a high dimension piecewise-linear dynamics model is built for the supply chain system. Five kinds of ordering policy combination are considered. The distribution of both the largest Lyapunov exponent of effective inventory and average operating cost per cycle is obtained by simulation in a policy space. The simulation shows that for the general discrete-type manufacturing industry supply chain system, the upper chaotic corners emerge besides the lower chaotic corners in the policy space expressing the distribution of system behaviour mode, and that the ordering policies at each supply chain node as well as their combination have very significant effect on the topology of the distribution of both system behaviour mode and operating cost in the policy space. We find that chaos is not always corresponding to high cost, and the "chaos amplification" is not completely relevant to the "cost amplification".

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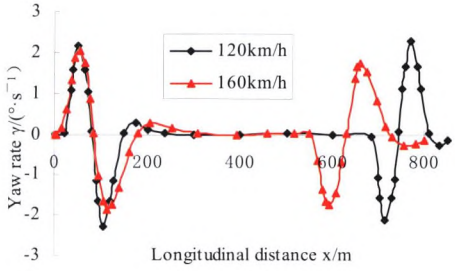
Advanced Transportation Equipment



DOI: 10.1186/s10033-018-0301-y

Minimum Time Overtaking Problem of Vehicle Handling Inverse Dynamics Based on Two Kinds of Safe Distances. You-Qun Zhao • Xing-Long Zhang • Wen-Xin Zhang • Fen Lin

Abstract: Overtaking accidents caused by improper operations performed by a driver occur frequently. However, most studies on overtaking safety have neglected research into driver control input. A novel method is proposed to obtain the driver control input during the overtaking process. Meanwhile, to improve the safety of overtaking, two types of safe distances, and the time of the overtaking are considered. Path constraints are established when considering the two types of safe distances. An optimal control model is established to solve the minimum time maneuver under multiple constraints. Using the Gauss pseudospectral method, the optimal control problem is converted into a nonlinear programming problem, which is then solved through sequential quadratic programming (SQP). In addition, the effectiveness of the proposed method is verified based on the results of a Carsim simulation. The simulation results show that by adopting an inverse dynamics method to solve the manipulation problem of the vehicle's minimum overtaking time, the manipulation capability of a vehicle in completing an overtaking safely within the minimum time can be obtained. This method can provide a reference for research into the active safety of manned and unmanned vehicles.

Smart Materials

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Effect of Micro-scale Y Addition on the Fracture Properties of Al-Cu-Mn Alloy. Ting-Biao Guo • Feng Zhang • Wan-Wu Ding • Zhi Jia

Abstract: Rare earth (RE) elements have positive effects on Al alloy, while most research is focused on microstructure and mechanical properties. As important application indices, toughness and plasticity are properties that are sensitive to alloy fracture characteristics, and few research studies have characterized the fracture properties of Al-Cu-Mn alloy on RE elements. The effect of different contents of Y on the fracture properties of Al-Cu-Mn alloy is investigated. T6 heat treatment (solid solution and artificial aging treatment), optical microscope (OM), scanning electron microscopy (SEM) and energy dispersive spectrometer (EDS) methods are applied to the alloy. Results showed that when Y element is present at 0.1%, the section of the as-cast alloy has smaller sized dimples and the fracture mode presents ductile features. Slight changes in hardness are also observed and maintained at about 60 HV. With increasing content of the RE element Y from 0.1 to 0.5%, the θ phase and Cu atoms in the matrix were reduced and most stopped at Grain boundaries (GBs). Micro-segregation and an enriched zone of Y near the GBs gradually increased. At the same time, the inter-metallic compound AlCuY is aggregated at grain junctions causing deterioration of the micro-structure and fracture properties of the alloy. After T6 treatment, the flatness of the fracture surface was lower than that of all the as-cast alloy showing lots of dimples and teared edges with a significant increase in hardness. When Y content was 0.1 %, the strength and hardness of the alloy increased due to refinement of the grain strengthening effect. The content of Y elements segregated in the inter-dendritic zone and GBs is reduced. Plasticity and deformation compatibility also improved, making cracks difficult to form and merge with each other along adjacent grain junctions and providing an increased potential for ductile fracture. This paper proposes the addition of RE Y as an effective and prospective strategy to improve the fracture properties of the Al-Cu-Mn alloy and provide a meaningful reference in terms of improving overall performance.

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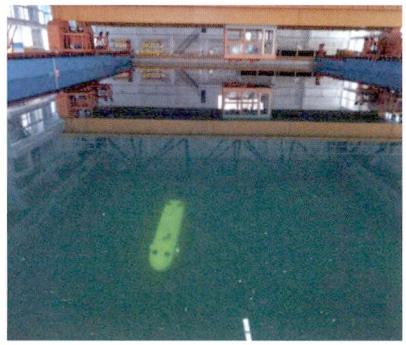
Ocean Engineering Equipment

DOI: 10.1186/s10033-018-0307-5

Adaptive Backstepping Terminal Sliding Mode Control Method Based on Recurrent Neural Networks for Autonomous Underwater Vehicle. Chao Yang • Feng Yao • Ming-Jun Zhang

Abstract: The trajectory tracking control problem is addressed for autonomous underwater vehicle (AUV) in marine environment, with presence of the influence of the uncertain factors including ocean current disturbance, dynamic modeling uncertainty, and thrust model errors. To improve the trajectory tracking accuracy of AUV, an adaptive backstepping terminal sliding mode control based on recurrent neural networks (RNN) is proposed. Firstly, considering the inaccurate of thrust model of thruster, a Taylor's polynomial is used to obtain the thrust model errors. And then, the dynamic modeling uncertainty and thrust model errors are combined into the system model uncertainty (SMU) of AUV; through the RNN, the SMU and ocean current disturbance are classified, approximated online. Finally, the weights of RNN and other control parameters are adjusted online based on the backstepping terminal sliding mode controller. In addition, a chattering-reduction method is proposed based on sigmoid function. In chattering-reduction method, the sigmoid function is used to realize the continuity of the sliding mode switching function, and the sliding mode switching gain is adjusted online based on the exponential form of the sliding mode function. Based on the Lyapunov theory and Barbalat's lemma, it is theoretically proved that the AUV trajectory tracking error can quickly converge to zero in the finite time. This research proposes a trajectory tracking control method of AUV, which can effectively achieve high-precision trajectory tracking control of AUV under the influence of the uncertain factors. The feasibility and effectiveness of the proposed method is demonstrated with trajectory tracking simulations and pool-experiments of AUV.



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