CMES Springer Open

ISSN 1000-9345 · CN 11-2737/TH · CODEN CJMEER

QK1859026

CHINESE JOURNAL OF MECHANICAL ENGINEERING®

中国机械工程学报

DOI: 10.1186/s10033-018-0278-6

Research and Realization of a Master-Slave Robotic System for Retinal Vascular Bypass Surgery

Chang-Yan He, Long Huang, Yang Yang , Qing-Feng Liang and Yong-Kang Li

CJME

2018 Vol. 31
August

CONTENTS

Vol. 31, August 2018

CHINESE JOURNAL OF MECHANICAL ENGINEERING

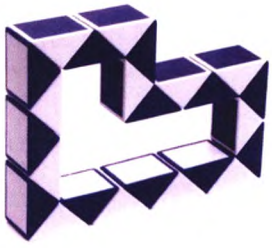
Review

DOI: 10.1186/s10033-018-0269-7

Overview of Rubik's Cube and Reflections on Its Application in Mechanism.

Da-Xing Zeng • Ming Li • Juan-Juan Wang • Yu-Lei Hou • Wen-Juan Lu • Zhen Huang

Abstract: Rubik's Cube is a widely popular mechanical puzzle that has attracted attention around the world because of its unique characteristics. As a classic brain-training toy well known to the public, Rubik's Cube was used for scientific research and technology development by many scholars. This paper provides a basic understanding of the Rubik's Cube and shows its mechanical art from the aspects of origin and development, characteristics, research status and especially its mechanical engineering design, as well as making a vision for the application in mechanism. First, the invention and origin of Rubik's Cube are presented, and then the special characteristics of the cube itself are analyzed. After that, the present researches of Rubik's Cube are reviewed in various disciplines at home and abroad, including the researches of Rubik's Cube scientific metaphors, reduction algorithms, characteristic applications, and mechanism issues. Finally, the applications and prospects of Rubik's Cube in the field of mechanism are discussed.

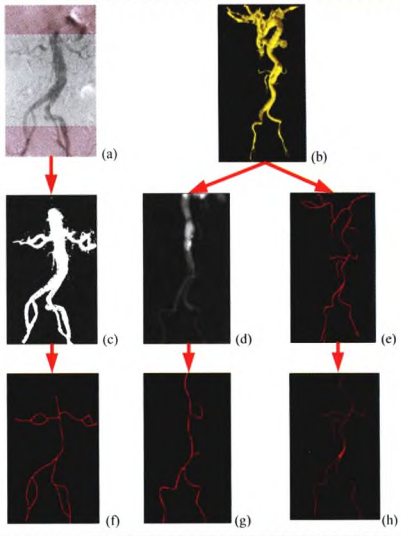


DOI: 10.1186/s10033-018-0275-9

A Review of Point Feature Based Medical Image Registration.

Shao-Ya Guan • Tian-Miao Wang • Cai Meng • Jun-Chen Wang

Abstract: Point features, as the basis of lines, surfaces, and bodies, are commonly used in medical image registration. To obtain an elegant spatial transformation of extracted feature points, many point set matching algorithms (PMs) have been developed to match two point sets by optimizing multifarious distance functions. There are ample reviews related to medical image registration and PMs which summarize their basic principles and main algorithms separately. However, to data, detailed summary of PMs used in medical image registration in different clinical environments has not been published. In this paper, we provide a comprehensive review of the existing key techniques of the PMs applied to medical image registration according to the basic principles and clinical applications. As the core technique of the PMs, geometric transformation models are elaborated in this paper, demonstrating the mechanism of point set registration. We also focus on the clinical applications of the PMs and propose a practical classification method according to their applications in different clinical surgeries. The aim of this paper is to provide a summary of point-feature-based methods used in medical image registration and to guide doctors or researchers interested in this field to choose appropriate techniques in their research.

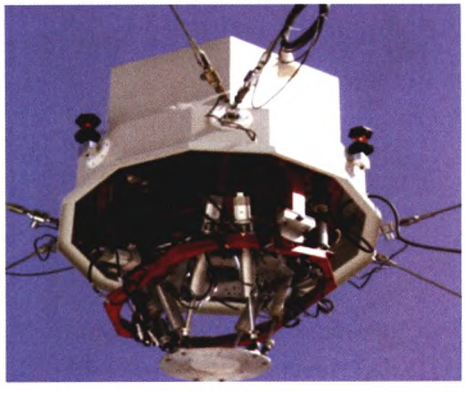


DOI: 10.1186/s10033-018-0267-9

A Review on Cable-driven Parallel Robots.

Sen Qian • Bin Zi • Wei-Wei Shang • Qing-Song Xu

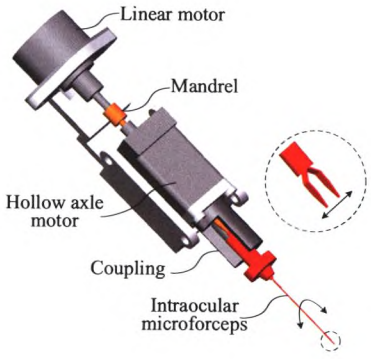
Abstract: Cable-driven parallel robots (CDPRs) are categorized as a type of parallel manipulators. In CDPRs, flexible cables are used to take the place of rigid links. The particular property of cables provides CDPRs several advantages, including larger workspaces, higher payload-to-weight ratio and lower manufacturing costs rather than rigid-link robots. In this paper, the history of the development of CDPRs is introduced and several successful latest application cases of CDPRs are presented. The theory development of CDPRs is introduced focusing on design, performance analysis and control theory. Research on CDPRs gains wide attention and is highly motivated by the modern engineering demand for large load capacity and workspace. A number of exciting advances in CDPRs are summarized in this paper since it is proposed in the 1980s, which points to a fruitful future both in theory and application. In order to meet the increasing requirements of robot in different areas, future steps foresee more in-depth research and extension applications of CDPRs including intelligent control, composite materials, integrated and reconfigurable design.



CONTENTS

Vol. 31, August 2018

Mechanism and Robotics

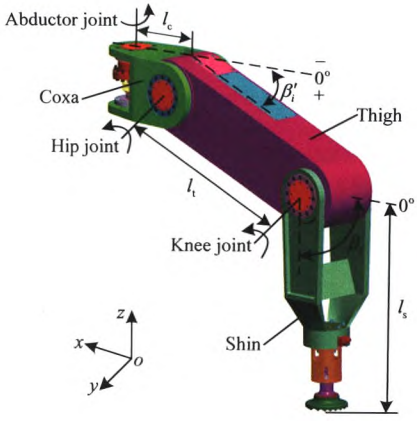


DOI: 10.1186/s10033-018-0278-6

Research and Realization of a Master-Slave Robotic System for Retinal Vascular Bypass Surgery.

Chang-Yan He • Long Huang • Yang Yang • Qing-Feng Liang • Yong-Kang Li

Abstract: Retinal surgery continues to be one of the most technical demanding surgeries for its high manipulation accuracy requirement, small and constrained workspace, and delicate retinal tissue. Robotic systems have the potential to enhance and expand the capabilities of surgeons during retinal surgery. Thus, focusing on retinal vessel bypass surgery, a master-slave robot system is developed in this paper. This robotic system is designed based on characteristics of retinal vascular bypass surgery and analysis of the surgical workspace in eyeball. A novel end-effector of two degrees of freedom is designed and a novel remote center of motion mechanism is adopted in the robot structure. The kinematics and the mapping relationship are then established, the gravity compensation control strategy and the hand tremor elimination algorithm are applied to achieve the high motion accuracy. The experiments on an artificial eyeball and an in vitro porcine eye are conducted, verifying the feasibility of this system.

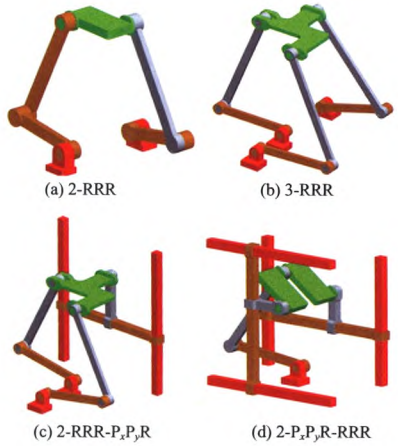


DOI: 10.1186/s10033-018-0263-0

Static Force Analysis of Foot of Electrically Driven Heavy-Duty Six-Legged Robot under Tripod Gait.

Zhen Liu • Hong-Chao Zhuang • Hai-Bo Gao • Zong-Quan Deng • Liang Ding

Abstract: The electrically driven six-legged robot with high carrying capacity is an indispensable equipment for planetary exploration, but it hinders its practicability because of its low efficiency of carrying energy. Meanwhile, its load capacity also affects its application range. To reduce the power consumption, increase the load to mass ratio, and improve the stability of robot, the relationship between the walking modes and the forces of feet under the tripod gait are researched for an electrically driven heavy-duty six-legged robot. Based on the configuration characteristics of electrically driven heavy-duty six-legged, the typical walking modes of robot are analyzed. The mathematical models of the normal forces of feet are respectively established under the tripod gait of typical walking modes. According to the MATLAB software, the variable tendency charts are respectively gained for the normal forces of feet. The walking experiments under the typical tripod gaits are implemented for the prototype of electrically driven heavy-duty six-legged robot. The variable tendencies of maximum normal forces of feet are acquired. The comparison results show that the theoretical and experimental data are in the same trend. The walking modes which are most available to realize the average force of distribution of each foot are confirmed. The proposed method of analyzing the relationship between the walking modes and the forces of feet can quickly determine the optimal walking mode and gait parameters under the average distribution of foot force, which is propitious to develop the excellent heavy-duty multi-legged robots with the lower power consumption, larger load to mass ratio, and higher stability.



DOI: 10.1186/s10033-018-0260-3

Structural Synthesis of Parallel Mechanisms with High Rotational Capability.

Xiao-Dong Jin • Yue-Fa Fang • Sheng Guo • Hai-Bo Qu

Abstract: Most parallel mechanisms (PMs) encountered today have a common disadvantage, i.e., their low rotational capability. In order to develop PMs with high rotational capability, a family of novel manipulators with one or two dimensional rotations is proposed. The planar one-rotational one-translational (1R1T) and one-rotational two-translational (1R2T) PMs evolved from the crank-and-rocker mechanism (CRM) are presented by means of Lie group theory. A spatial 2R1T PM and a 2R parallel moving platform with bifurcated large-angle rotations are proposed by orthogonal combination of the RRRR limbs. According to the product principle of the displacement group theory, a hybrid 2R3T mechanism in possession of bifurcated motion is obtained by connecting the 2R parallel moving platform with a parallel part, which is constructed by four 3T1R kinematic chains. The presented manipulators possess high rotational capability. The proposed research enriches the family of spatial mechanisms and the construction method provides an instruction to design more complex mechanisms.

CONTENTS

Vol. 31, August 2018

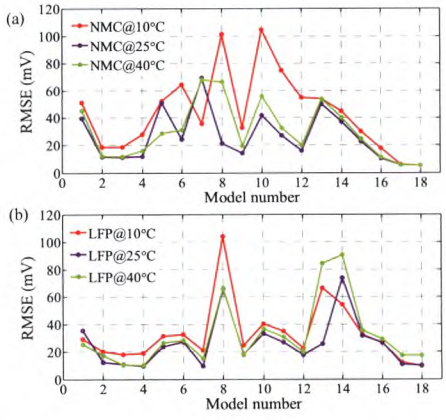
Advanced Transportation Equipment

DOI: 10.1186/s10033-018-0268-8

A Comparative Study on Open Circuit Voltage Models for Lithium-ion Batteries.

Quan-Qing Yu • Rui Xiong • Le-Yi Wang • Cheng Lin

Abstract: The current research of state of charge (SoC) online estimation of lithium-ion battery (LiB) in electric vehicles (EVs) mainly focuses on adopting or improving of battery models and estimation filters. However, little attention has been paid to the accuracy of various open circuit voltage (OCV) models for correcting the SoC with aid of the ampere-hour counting method. This paper presents a comprehensive comparison study on eighteen OCV models which cover the majority of models used in literature. The low-current OCV tests are conducted on the typical commercial $LiFePO_4$/graphite (LFP) and $LiNiMnCoO_2$/graphite (NMC) cells to obtain the experimental OCV-SoC curves at different ambient temperature and aging stages. With selected OCV and SoC points from experimental OCV-SoC curves, the parameters of each OCV model are determined by curve fitting toolbox of MATLAB 2013. Then the fitting OCV-SoC curves based on diversified OCV models are also obtained. The indicator of root-mean-square error (RMSE) between the experimental data and fitted data is selected to evaluate the adaptabilities of these OCV models for their main features, advantages, and limitations. The sensitivities of OCV models to ambient temperatures, aging stages, numbers of data points, and SoC regions are studied for both NMC and LFP cells. Furthermore, the influences of these models on SoC estimation are discussed. Through a comprehensive comparison and analysis on OCV models, some recommendations in selecting OCV models for both NMC and LFP cells are given.



DOI: 10.1186/s10033-018-0273-y

Influence Analysis of Machining and Installation Errors on the Radial Stiffness of a Non-Pneumatic Mechanical Elastic Wheel.

You-Qun Zhao • Zhen Xiao • Fen Lin • Ming-Min Zhu • Yao-Ji Deng

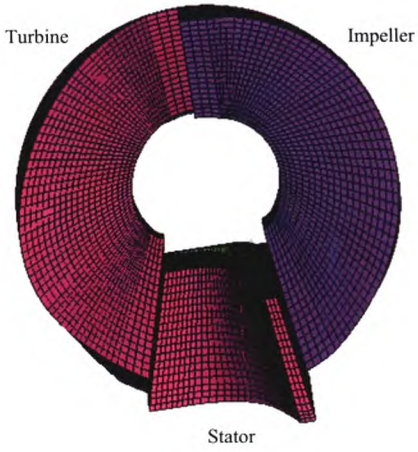
Abstract: Machining and installation errors are unavoidable in mechanical structures. However, the effect of errors on radial stiffness of the mechanical elastic wheel (ME-Wheel) is not considered in previous studies. To this end, the interval mathematical model and interval finite element model of the ME-Wheel were both established and compared with bench test results. The intercomparison of the influence of the machining and installation errors on the ME-wheel radial stiffness revealed good consistency among the interval mathematical analysis, interval finite element simulation, and bench test results. Within the interval range of the ME-Wheel machining and installation errors, parametric analysis of the combined elastic rings was performed at different initial radial rigidity values. The results showed that the initial radial stiffness of the flexible tire body significantly influenced the ME-Wheel radial stiffness, and the inverse relationship between the hinge unit length or suspension hub and the radial stiffness was nonlinear. The radial stiffness of the ME-Wheel is predicted by using the interval algorithm for the first time, and the regularity of the radial stiffness between the error and the load on the ME-Wheel is studied, which will lay the foundation for the exact study of the ME-Wheel dynamic characteristics in the future.

DOI: 10.1186/s10033-018-0262-1

Performance Analysis and Improvement of Flat Torque Converters Using DOE Method.

Guang-Qiang Wu • Jie Chen • Wen-Jie Zhu

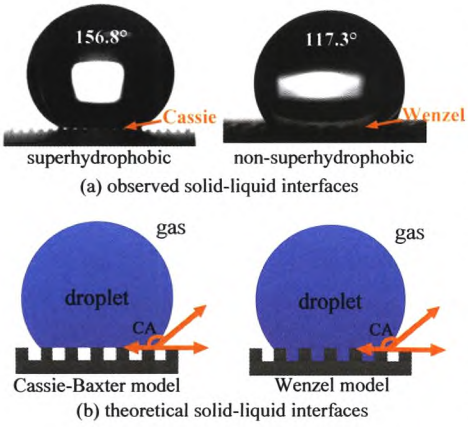
Abstract: Automotive torque converters have recently been designed with an increasingly narrower profile for the purpose of achieving a smaller axial size and reducing weight. Design of experiment (DOE) and computational fluid dynamics (CFD) techniques are applied to improve the performance of a flat torque converter. Four torque converters with different flatness ratios (0.204, 0.186, 0.172, and 0.158) are designed and simulated first to investigate the effects of flatness ratio on their overall performance, including efficiency, torque ratio, and impeller torque factor. The simulation results show that the overall performance tends to deteriorate as the flatness ratio decreases. Then a parametric study covering six geometric parameters, namely, inlet and outlet angles of impeller, turbine, and stator is carried out. The results demonstrate that the inlet and outlet angles play an important role in determining the performance characteristics of a torque converter. Furthermore, the relative importance of the six design parameters is investigated using DOE method for each response (stall torque ratio and peak efficiency). The turbine outlet angle is found to exert the greatest influence on both responses. After DOE analysis, an optimized design for the flat torque converter geometry is obtained. Compared to the conventional product, the width of the optimized flat torque converter torus is reduced by about 20% while the values of stall torque ratio and peak efficiency are only decreased by 0.4% and 1.7%, respectively. The proposed new optimization strategy based on DOE method together with desirability function approach can be used for performance enhancement in the design process of flat torque converters.



CONTENTS

Vol. 31, August 2018

Intelligent Manufacturing Technology

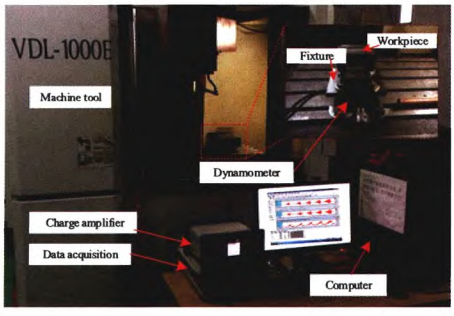


DOI: 10.1186/s10033-018-0270-1

Fabrication of Superhydrophobic Micro Post Array on Aluminum Substrates Using Mask Electrochemical Machining.

Jing Sun • Wei Cheng • Jin-Long Song • Yao Lu • Yan-Kui Sun • Liu Huang • Xin Liu • Zhu-Ji Jin • Claire J. Carmalt • Ivan P. Parkin

Abstract: Surfaces with controllable micro structures are significant in fundamental development of superhydrophobicity. However, preparation of superhydrophobic surfaces with array structures on metal substrates is not effective using existing methods. A new method was presented to fabricate super -hydrophobic post arrays on aluminum (Al) substrates using mask electrochemical machining (MECM) and fluoridation. Electrochemical etching was first applied on Al plates with pre-prepared photoresist arrays to make the post array structures. Surface modification was subsequently applied to reduce the surface energy, followed by interaction with water to realize superhydrophobicity. Simulation and experimental verification were conducted to investigate how machining parameters affect the array structures. Analysis of the water contact angle (CA) was implemented to explore the relationship between wettability and micro structures. The results indicate that superhydrophobic surfaces with controllable post structures can be fabricated through this proposed method, producing surfaces with high water static contact angles.

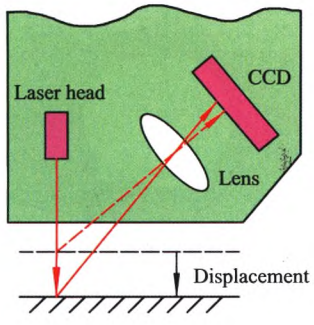


DOI: 10.1186/s10033-018-0271-0

Experimental Evaluation on Grinding Texture on Flank Face in Chamfer Milling of Stainless Steel.

Xian-Li Liu • Jin-Kui Shi • Wei Ji • Li-Hui Wang

Abstract: The surface quality of chamfer milling of stainless steel is closed related to the products of 3C (Computer, Communication and Consumer electronics), where a cutter is a major part to achieve that. Targeting a high-quality cutter, an experimental evaluation is carried out on the influence of grinding texture of cutter flank face on surface quality. The mathematic models of chamfer cutter are established, and they are validated by a numerical simulation. Also the grinding data are generated by the models and tested by a grinding simulation for safety reasons. Then, a set of chamfer cutting tools are machined in a five-axis CNC grinding machine, and consist of five angles between the cutting edge and the grinding texture on the 1st flank faces, i.e., 0°, 15°, 30°, 45° and 60°. Furthermore, the machined cutting tools are tested in a series of milling experiments of chamfer hole of stainless steel, where cutting forces and surface morphologies are measured and observed. The results show that the best state of both surface quality and cutting force is archived by the tool with 45° grinding texture, which can provide a support for manufacturing of cutting tool used in chamfer milling.



DOI: 10.1186/s10033-018-0265-y

New Measurement Method for Spline Shaft Rolling Performance Evaluation using Laser Displacement Sensor.

Hong-Wei Li • Zhi-Qiang Liang • Jia-Jie Pei • Li Jiao • Li-Jing Xie • Xi-Bin Wang

Abstract: In order to control the quality of spline shaft in rolling process, an efficient measurement method for rolling performance evaluation is essential. Here, a newly developed on-machine non-contact measurement prototype based on laser displacement sensor and rotary encoder is proposed. The prototype is intended for the automated evaluation of the spline shaft rolling performance by measuring the dimensional change of tooth root, which is correlated with the surface residual stress and micro-hardness. Laser displacement sensor and rotary encoder are used to record the polar radius and polar angle of each point on measuring section. Data are displayed in a polar coordinate system and fitted in a gear. Through multipoint curvature method, the roots of spline shaft are recognized automatically. Then, the dimensional change can be calculated by fitting the radius of the tooth root circle before and after rolling. Systematic error covering offset error is also analyzed and calibrated. At last, measurement test results show that the system has advantages of simple structure, high measurement precision (radius error <0.6 μm), high measurement efficiency (measuring time <2 s) and automatic control ability, providing a new opportunity for the efficient evaluation of various spline shafts in high-precision mechanical processing.

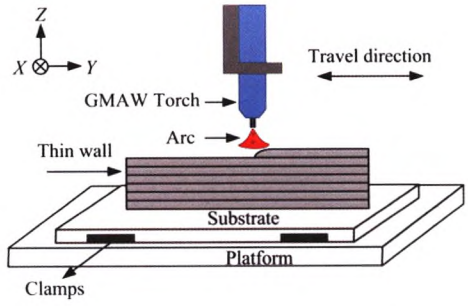
CONTENTS

Vol. 31, August 2018

DOI: 10.1186/s10033-018-0276-8

Determination of Surface Roughness in Wire and Arc Additive Manufacturing Based on Laser Vision Sensing.

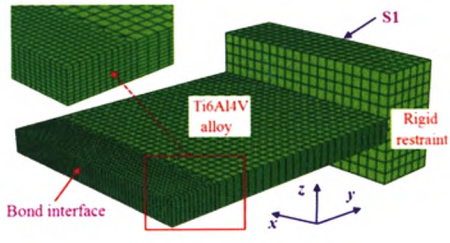
Jun Xiong • Yan-Jiang Li • Zi-Qiu Yin • Hui Chen



Abstract: Wire and arc additive manufacturing (WAAM) shows a great promise for fabricating fully dense metal parts by means of melting materials in layers using a welding heat source. However, due to a large layer height produced in WAAM, an unsatisfactory surface roughness of parts processed by this technology has been a key issue. A methodology based on laser vision sensing is proposed to quantitatively calculate the surface roughness of parts deposited by WAAM. Calibrations for a camera and a laser plane of the optical system are presented. The reconstruction precision of the laser vision system is verified by a standard workpiece. Additionally, this determination approach is utilized to calculate the surface roughness of a multi-layer single-pass thin-walled part. The results indicate that the optical measurement approach based on the laser vision sensing is a simple and effective way to characterize the surface roughness of parts deposited by WAAM. The maximum absolute error is less than 0.15 mm. The proposed research provides the foundation for surface roughness optimization with different process parameters.

DOI: 10.1186/s10033-018-0266-x

Numerical Study on the Stress-Strain Cycle of Thermal Self-Compressing Bonding. Yun-Hua Deng • Qiao Guan • Jun Tao • Bing Wu

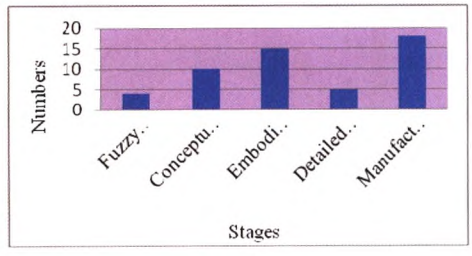


Abstract: Thermal self-compressing bonding (TSCB) is a new solid-state bonding method pioneered by the authors. With electron beam as the non-melted heat source, previous experimental study performed on titanium alloys has proved the feasibility of TSCB. However, the thermal stress-strain process during bonding, which is of very important significance in revealing the mechanism of TSCB, was not analysed. In this paper, finite element analysis method is adopted to numerically study the thermal elasto-plastic stress-strain cycle of thermal self-compressing bonding. It is found that due to the localized heating, a non-uniform temperature distribution is formed during bonding, with the highest temperature existed on the bond interface. The expansion of high temperature materials adjacent to the bond interface are restrained by surrounding cool materials and rigid restraints, and thus an internal elasto-plastic stress-strain field is developed by itself which makes the bond interface subjected to thermal compressive action. This thermal self-compressing action combined with the high temperature on the bond interface promotes the atom diffusion across the bond interface to produce solid-state joints. Due to the relatively large plastic deformation, rigid restraint TSCB obtains sound joints in relatively short time compared to diffusion bonding.

DOI: 10.1186/s10033-018-0274-x

Research on Opportunity-Driven Redesign Process To Cooperate With Training Innovative Engineers in China.

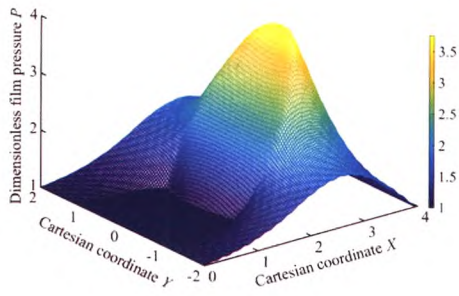
Run-Hua Tan • Ya-Fan Dong • Bo-Jun Yang • Peng Zhang



Abstract: Many design engineers in cross-domain industries have attended training classes of TRIZ to improve their innovative abilities in China. Most of them are successful, but others are not. So the latest target of the trainers is to improve the training process used now in industry in China and to make the engineers to understand the basic principles of TRIZ better. Based on the mass-engineer-oriented training model (MEOTM) and mechanical engineers' design cases, a relationship between managing activities about the opportunities for innovation and the training process is set up. It is shown that the inventive problems come first from opportunity searching for engineers. A training and gate system for evaluation is developed to involve the managing activities of the companies in the training process. Then comparison between the general analogous process and the application of TRIZ is made, which shows the advantages and depth principles of TRIZ for the engineers to apply them confidently. Lastly a new process is formed in which opportunity searching, engineers training, inventive problems identifying and solving, and three redesign paths are connected seamlessly. The research proposes an opportunity-driven redesign path that cooperates the training and opportunity searching, which will be applied in future training classes to make more and more engineers to follow.

CONTENTS

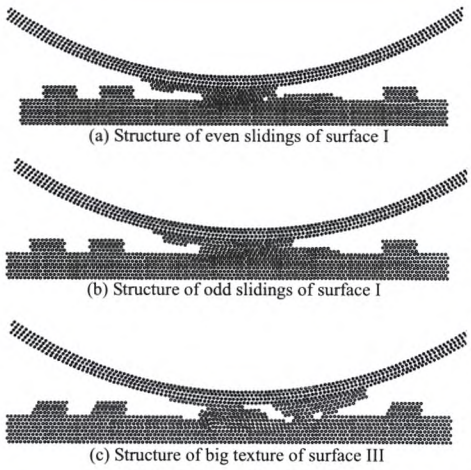
Vol. 31, August 2018



DOI: 10.1186/s10033-018-0272-z

Effect of Micro-Dimples on Hydrodynamic Lubrication of Textured Sinusoidal Roughness Surfaces. Jing-Hu Ji • Cai-Wei Guan • Yong-Hong Fu

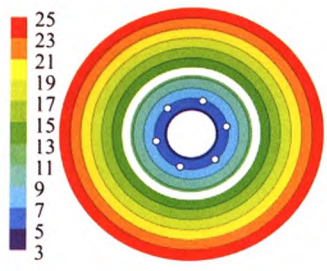
Abstract: Surface texturing has been applied to improving the tribological performance of mechanical components for many years. Currently, the researches simulate the film pressure distribution of textured rough surfaces on the basis of the average flow model, and however the influence of roughness on the film pressure distribution could not be precisely expressed. Therefore, in order to study the hydrodynamic lubrication of the rough textured surfaces, sinusoidal waves are employed to characterize untextured surfaces. A deterministic model for hydrodynamic lubrication of micro-dimple textured rough surfaces is developed to predict the distribution of hydrodynamic pressure. By supplementing with the JFO cavitation boundary, the load carrying capacity of the film produced by micro-dimples and roughness is obtained. And the geometric parameters of textured rough surface are optimized to obtain the maximum hydrodynamic lubrication by specifying an optimization goal of the load carrying capacity. The effect of roughness on the hydrodynamic pressure of surface texture is significant and the load carrying capacity decreases with the increase of the roughness ratio because the roughness greatly suppresses the hydrodynamic effect of dimples. It shows that the roughness ratio of surface may be as small as possible to suppress the effect of hydrodynamic lubrication. Additionally, there are the optimum values of the micro-dimple depth and area density to maximize the load carrying capacity for any given value of the roughness ratio. The proposed approach is capable of accurately reflects the influence of roughness on the hydrodynamic pressure, and developed a deterministic model to investigate the hydrodynamic lubrication of textured surfaces.



DOI: 10.1186/s10033-018-0261-2

Nanoscale Reciprocating Sliding Contacts of Textured Surfaces: Influence of Structure Parameters and Indentation Depth. Rui-Ting Tong • Geng Liu

Abstract: Textured surfaces are widely used in engineering components as they can improve tribological properties of sliding contacts, while the detailed behaviors of nanoscale reciprocating sliding contacts of textured surfaces are still lack of study. By using multiscale method, two dimensional nanoscale reciprocating sliding contacts of textured surfaces are investigated. The influence of indentation depth, texture shape, texture spacing, and tip radius on the average friction forces and the running-in stages is studied. The results show that the lowest indentation depth can make all the four textured surfaces reach steady state. Surfaces with right-angled trapezoid textures on the right side are better for reducing the running-in stage, and surfaces with right-angled trapezoid textures on the left side are better to reduce wear. Compared with other textured surfaces, the total average friction forces can be reduced by 82.94%–91.49% for the case of the contact between the tip with radius R=60r_0 and the isosceles trapezoid textured surface. Besides, the total average friction forces increase with the tip radii due to that bigger tip will induce higher contact areas. This research proposes a detailed study on nanoscale reciprocating sliding contacts of textured surfaces, to contribute to design textured surfaces, reduce friction and wear.



DOI: 10.1186/s10033-018-0264-z

Numerical Investigation of the Fluid Flow Characteristics in the Hub Plate Crown of a Centrifugal Pump. Wei Dong • Wu-Li Chu

Abstract: Due to the lack of understanding in the flow mechanism of the hub plate crown, the current calculation of the disc friction loss and the axial thrust in the centrifugal pump often uses empirical formulas. Research on the flow characteristics of the hub plate crown is of practical significance. The shroud and hub cavities are respectively studied with regard to tangential and radial velocities at the four different angular positions (0°, 90°, 180°, and 270°) at the four different operational points (0.6Q_{sp}, 0.8Q_{sp}, 1.0Q_{sp}, and 1.2Q_{sp}). Results indicate that at the same operational point, the smaller the volute chamber sectional area is, the higher the tangential velocity of the fluid core zone of the shroud cavity is. Radial leakage flow from the volute to the seal ring at the same operational point appears in 0° and 90° direction; when the flow is large, the tangential and radial velocities of the shroud and hub cavities with the same radius tend to be equal with axial symmetry. The axial leakage flow through the balance holes significantly affects the radial distribution of both tangential and radial velocities of fluid flow in the hub cavity. The numerical calculation results of fluid leakage through the clearance of back sealing ring are in good agreement with the test results. Accordingly, the magnitude of leakage is closely related to the fluid pressure and velocity distribution in the hub plate crown of the centrifugal pump. The analysis of the flow characteristics in the hub plate crown of the centrifugal pump could reveal the cause of the disc friction loss from the mechanism, providing a significant guidance for improving the accuracy of calculation and balancing the axial thrust in the centrifugal pump.

CONTENTS

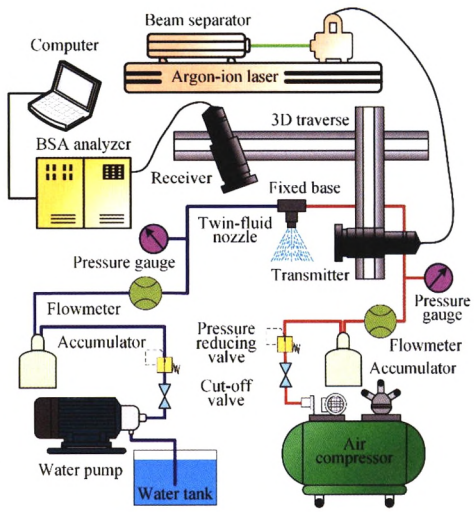
Vol. 31, August 2018

DOI: 10.1186/s10033-018-0277-7

Influence of Self-excited Vibrating Cavity Structure on Droplet Diameter Characteristics of Twin-fluid Nozzle.

Bo Chen • Dian-Rong Gao • Shao-Feng Wu • Jian-Hua Zhao

Abstract: It is a great challenge to find effective atomizing technology for reducing industrial pollution; the twin-fluid atomizing nozzle has drawn great attention in this field recently. Current studies on twin-fluid nozzles mainly focus on droplet breakup and single droplet characteristics. Research relating to the influences of structural parameters on the droplet diameter characteristics in the flow field is scarcely available. In this paper, the influence of a self-excited vibrating cavity structure on droplet diameter characteristics was investigated. Twin-fluid atomizing tests were performed by a self-built open atomizing test bench, which was based on a phase Doppler particle analyzer (PDPA). The atomizing flow field of the twin-fluid nozzle with a self-excited vibrating cavity and its absence were tested and analyzed. Then the atomizing flow field of the twin-fluid nozzle with different self-excited vibrating cavity structures was investigated. The experimental results show that the structural parameters of the self-excited vibrating cavity had a great effect on the breakup of large droplets. The Sauter mean diameter (SMD) increased with the increase of orifice diameter or orifice depth. Moreover, a smaller orifice diameter or orifice depth was beneficial to enhancing the turbulence around the outlet of nozzle and decreasing the SMD. The atomizing performance was better when the orifice diameter was 2.0 mm or the orifice depth was 1.5 mm. Furthermore, the SMD increased first and then decreased with the increase of the distance between the nozzle outlet and self-excited vibrating cavity, and the SMD of more than half the atomizing flow field was under 35 μm when the distance was 5.0 mm. In addition, with the increase of axial and radial distance from the nozzle outlet, the SMD and arithmetic mean diameter (AMD) tend to increase. The research results provide some design parameters for the twin-fluid nozzle, and the experimental results could serve as a beneficial supplement to the twin-fluid nozzle study.

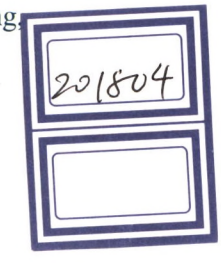


CHINESE JOURNAL OF MECHANICAL ENGINEERING

中国机械工程学报

(Bimonthly, Started in 1988)
Vol. 31, August 2018

Supervised by China Association for Science and Technology
Sponsored by Chinese Mechanical Engineering Society
Associated to IFToMM



Edited by Editorial Office of Chinese Journal of Mechanical Engineering
Address: 22 Baiwanzhuang Dajie, Beijing 100037, China
Tel: +86-10-88379909
Fax: +86-10-68994557
http: //www.cjmenet.com
E-mail: cjme@cjmenet.com

Printed by Beijing BOHS Colour Printing Co., Ltd.
Subscriptions in China Post offices throughout China
Postal Code: 2-377
Subscription Price in China: ¥ 100

Coverage in Abstracting & Indexing (A&I) Services: Science Citation Index Expanded (SciSearch), Journal Citation Reports/ Science Edition, SCOPUS, DOAJ, INSPEC, Zentralblatt Math, Chemical Abstracts Service (CAS), Google Scholar, CSA, Chinese Science Citation Database, Earthquake Engineering Abstracts, EI-Compendex, OCLC, SCImago, Summon by ProQuest

Online Submission
For enquiries relating to the submission of articles (including electronic submission where available), please visit http: //www.editorialmanager.com/chme, www.cjmenet.com, or cjme.springeropen.com

ISSN 1000-9345