CMES 中国机械工程学会
Springer Open
ISSN 1000-9345 · e-ISSN 2192-8258
CN 11-2737/TH · CODEN CJMEER

CHINESE JOURNAL OF MECHANICAL ENGINEERING®

Tire Road Friction

Tire Road Friction Coefficient Estimation: Review and Research Perspectives
Yan Wang, Jingyu Hu, Fa'an Wang, Haoxuan Dong, Yongjun Yan, Yanjun Ren, Chaobin Zhou and Guodong Yin
DOI: 10.1186/s10033-021-00675-z

CJME
Vol. 35, No. 2
April 2022

CONTENTS

Vol. 35, No. 2, April, 2022

CHINESE JOURNAL OF MECHANICAL ENGINEERING

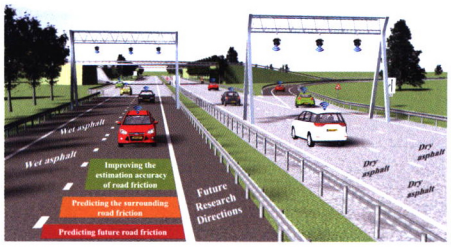
Review

(2022)35:6
DOI: 10.1186/s10033-021-00675-z

Tire Road Friction Coefficient Estimation: Review and Research Perspectives

Yan Wang • Jingyu Hu • Fa'an Wang • Haoxuan Dong • YongjunYan • Yanjun Ren • Chaobin Zhou • Guodong Yin

Abstract: Many surveys on vehicle traffic safety have shown that the tire road friction coefficient (TRFC) is correlated with the probability of an accident. The probability of road accidents increases sharply on slippery road surfaces. Therefore, accurate knowledge of TRFC contributes to the optimization of driver maneuvers for further improving the safety of intelligent vehicles. A large number of researchers have employed different tools and proposed different algorithms to obtain TRFC. This work investigates these different methods that have been widely utilized to estimate TRFC. These methods are divided into three main categories: off-board sensors-based, vehicle dynamics-based, and data-driven-based methods. This review provides a comparative analysis of these methods and describes their strengths and weaknesses. Moreover, some future research directions regarding TRFC estimation are presented.

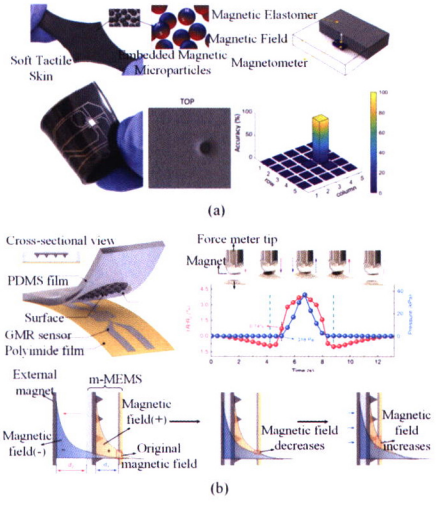


(2022)35:37
DOI: 10.1186/s10033-022-00707-2

A Review of Smart Materials for the Boost of Soft Actuators, Soft Sensors, and Robotics Applications

Yufei Hao • Shixin Zhang • Bin Fang • Fuchun Sun • Huaping Liu • Haiyuan Li

Abstract: With the advance of smart material science, robotics is evolving from rigid robots to soft robots. Compared to rigid robots, soft robots can safely interact with the environment, easily navigate in unstructured fields, and be minimized to operate in narrow spaces, owning to the new actuation and sensing technologies developed by the smart materials. In the review, different actuation and sensing technologies based on different smart materials are analyzed and summarized. According to the driving or feedback signals, actuators are categorized into electrically responsive actuators, thermally responsive actuators, magnetically responsive actuators, and photoresponsive actuators; sensors are categorized into resistive sensors, capacitive sensors, magnetic sensors, and optical waveguide sensors. After introducing the principle and several robotic prototypes of some typical materials in each category of the actuators and sensors. The advantages and disadvantages of the actuators and sensors are compared based on the categories, and their potential applications in robotics are also presented.



CONTENTS

Vol. 35, No. 2, April, 2022

Mechanism and Robotics

CONTENTS

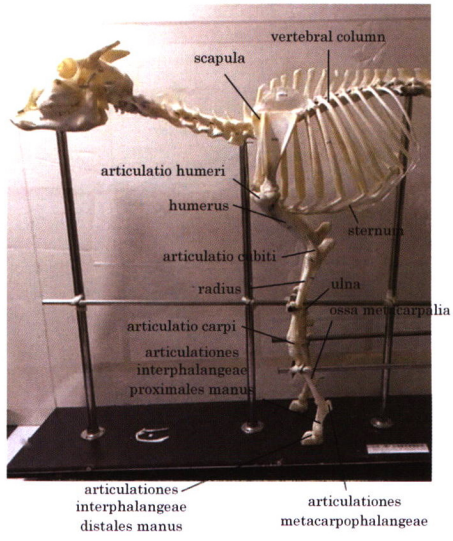
Vol. 35, No. 2, April, 2022

(2022)35:32
DOI: 10.1186/s10033-022-00700-9

Bionic Design and Analysis of a Novel Quadruped Robot with a Multistage Buffer System

Yi Zheng • Kun Xu • Yaobin Tian • Huichao Deng • Xilun Ding

Abstract: Large quadruped mammals, such as ruminants, have outstanding motion ability, including running and bounding. These advanced motion abilities are related to the buffer effect of their complicated musculoskeletal systems. However, the buffer effect of most bio-robots is not satisfactory owing to the simple design of their buffer systems. In this paper, a physiological analysis of the ruminant musculoskeletal system is presented to explain the intrinsic buffer mechanism of motion. Based on the physical buffer parts of the ruminant limbs, the corresponding bionic mappings were determined. These mappings were used to guide the mechanism design of the robot multistage buffer system. The multistage buffer system includes two main buffer mechanisms: the first stage and the second stage. The buffer mechanism analysis of the first stage and multiple stages is discussed in theory to compare the effects between the normal single buffer system and the novel multistage buffer system. Then, the detailed mechanical structure of the limbs was designed based on the limb mechanism design. To further verify the superior efficacy of the multistage buffer system, the corresponding walking simulation experiments were conducted after the virtual prototype of a quadruped robot with a novel limb was built completely. Both theoretical analysis and simulation experiments prove that the bionic robot design with the novel multistage buffer system achieves better motion performance than the traditional robot buffer design and can be regarded as the design template of the robot limb.

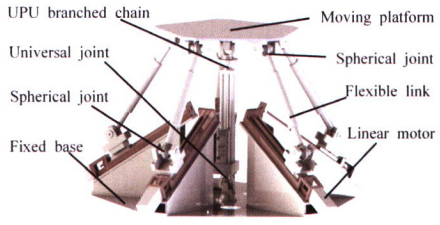


(2022)35:33
DOI: 10.1186/s10033-022-00693-5

Dynamic Accuracy Analysis of a 5PSS/UPU Parallel Mechanism Based on Rigid-Flexible Coupled Modeling

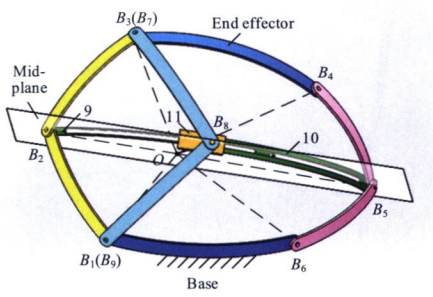
Yanbiao Li • Zesheng Wang • Chaoqun Chen • Taotao Xu • Bo Chen

Abstract: In order to improve the low output accuracy caused by the elastic deformations of the branch chains, a finite element-based dynamic accuracy analysis method for parallel mechanisms is proposed in this paper. First, taking a 5-prismatic-spherical-spherical (PSS)/ universal-prismatic-universal (UPU) parallel mechanism as an example, the error model is established by a closed vector chain method, while its influence on the dynamic accuracy of the parallel mechanism is analyzed through numerical simulation. According to the structural and error characteristics of the parallel mechanism, a vector calibration algorithm is proposed to reduce the position and pose errors along the whole motion trajectory. Then, considering the elastic deformation of the rod, the rigid-flexible coupling dynamic equations of each component are established by combining the finite element method with the Lagrange method. The elastodynamic model of the whole machine is obtained based on the constraint condition of each moving part, and the correctness of the model is verified by simulation. Moreover, the effect of component flexibility on the dimensionless root mean square error of the displacement, velocity and acceleration of the moving platform is investigated by using a Newmark method, and the mapping relationship of these dimensionless root mean square errors to dynamic accuracy is further studied. The research work provides a theoretical basis for the design of the parameter size of the prototype.



CONTENTS

Vol. 35, No. 2, April, 2022

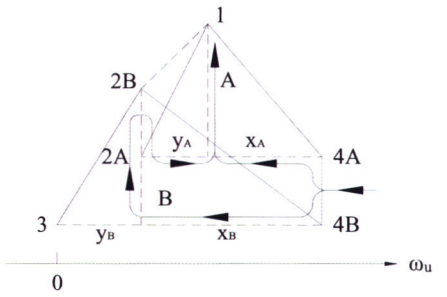


(2022)35:29
DOI: 10.1186/s10033-022-00702-7

Motion Characteristics Analysis of a Novel Spherical Two-degree-of-freedom Parallel Mechanism

Ziming Chen • Xuechan Chen • Min Gao • Chen Zhao • Kun Zhao • Yanwen Li

Abstract: Current research on spherical parallel mechanisms (SPMs) mainly focus on surgical robots, exoskeleton robots, entertainment equipment, and other fields. However, compared with the SPM, the structure types and research contents of the SPM are not abundant enough. In this paper, a novel two-degree-of-freedom (2DOF) SPM with symmetrical structure is proposed and analyzed. First, the models of forward kinematics and inverse kinematics are established based on D-H parameters, and the Jacobian matrix of the mechanism is obtained and verified. Second, the workspace of the mechanism is obtained according to inverse kinematics and link interference conditions. Next, rotational characteristics analysis shows that the end effector can achieve continuous rotation about an axis located in the mid-plane and passing through the rotation center of the mechanism. Moreover, the rotational characteristics of the mechanism are proved, and motion planning is carried out. A numerical example is given to verify the kinematics analysis and motion planning. Finally, some variant mechanisms can be synthesized. This work lays the foundation for the motion control and practical application of this 2DOF SPM.



(2022)35:27
DOI: 10.1186/s10033-022-00703-6

Recirculation of Parallel-Connected Planetary Gear Trains

Hong Chen • Xiao-An Chen

Abstract: Recirculation is expected to be identified for its possibility to dramatically decrease the efficiency of planetary gear trains (PGTs). However, it exhibits an unexplained connection with the structure, making it challenging to identify without tedious computation through tooth and speed ratios, thus complicating the design process. This study employs a generic model utilizing the mechanical balance principle and reveals the fundamental laws of the previously unexplained connection for parallel-connected ring-sun-type PGTs. Two necessary and sufficient conditions, torque and structure, were proven for multi-stage and two-stage PGTs without recirculation, respectively. This shows that the structure, specifically whether the links are central gears or carriers, and the connections between them directly impact the recirculation of these PGTs. A geometric model representing the structure and kinematics was developed to visualize the power flow. Thus, the recirculation of parallel-connected ring-sun-type PGTs can be predicted without calculations. Our results provide the underlying insights to understanding recirculation from the structural connection viewpoint, thereby contributing to the conceptual design phase where the task is to select the kinematic structure and the gear size is unknown.

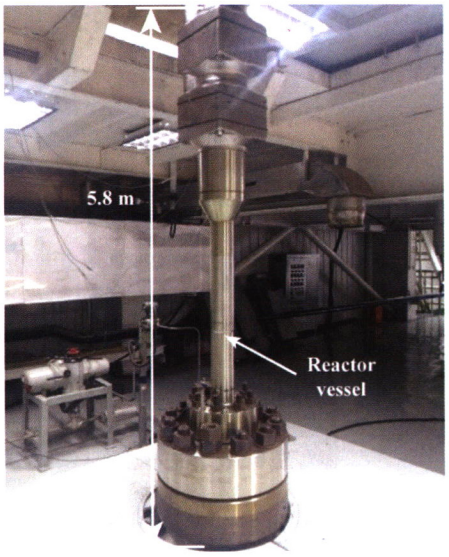
CONTENTS

Vol. 35, No. 2, April, 2022

DOI: 10.1186/s10033-022-00695-3

Wear Characteristics of the Nuclear Control Rod Drive Mechanism (CRDM) Movable Latch Serviced in High Temperature Water

Tianda Yu • Guozhong Fu • Yanqing Yu • Liting Zhu • Maofu Liu • Wei Li • Qiang Deng • Zhenbing Cai



Abstract: The current research of nuclear control rod drive mechanism (CRDM) movable latch only makes a simple measurement of wear mass. The wear volume and difference in various claw surfaces are ignored and the degradation mechanism of each claw surface is not clear. In this paper, a detailed degradation analysis was carried out on each claw surface of movable latch combined with wear result and worn morphology. Results indicate that the boundary of carbide is preferred for corrosion because carbide presents a nobler Volta potential compared to the metal matrix or boundary region. Due to the oscillation of drive shaft between the claw surfaces of movable latch, the dominant wear mechanism on the upper surface of claw (USC) and lower surface of claw (LSC) is plastic deformation caused by impact wear. Mechanical impact wear will cause the fragmentation of carbides because of the high hardness and low ductility of carbides. Corrosion promotes the broken carbides to fall off from the metal matrix. The generated fine carbides (abrasive particles) cause extra abrasive wear on USC when the movable brings the drive shaft upward or downward. As a result, USC has a higher wear volume than LSC. This research proposes a method to evaluate the wear on the whole movable latches using a 3D full-size scanner.

DOI: 10.1186/s10033-022-00699-z

A Φ 6-m Tunnel Boring Machine Steel Arch Splicing Manipulator

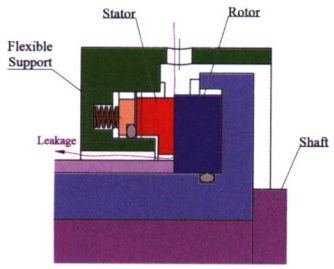
Yuanfu He • Yimin Xia • Zhen Xu • Jie Yao • Bo Ning • Xuemeng Xiao

Abstract: Robotic splicing of steel arches is a challenging task that is necessary to realize the grasping and docking of steel arches in a limited space. Steel arches often have a mass of more than 200 kg and length of more than 4 m. Owing to the large volume and mass of steel arches and the high requirements for accurately positioning the splicing, it is difficult for a general manipulator to meet the stiffness requirements. To enhance the structural stiffness of the steel arch splicing manipulator, a single-degree-of-freedom (DOF) closed-loop mechanism was added to the grasping structure of the manipulator. Based on the basic principle of structural synthesis, a solution model of the single-DOF closed-loop mechanism was developed, and alternative kinematic pairs of the mechanism with different input constraints and output requirements were derived. Based on this model, a design method for a single-DOF closed-loop grasping mechanism and a posture adjustment mechanism for a steel arch was devised. Combined with the same dimensional subspace equivalence principle of the graphical-type synthesis method, 12 types of steel arch splicing manipulator were constructed. By analyzing the motion/force transmission and structural complexity of the steel arch splicing manipulators, the best scheme was selected. A prototype of the steel arch splicing manipulator was manufactured. Adams software was used to obtain clearly the output trajectory of the end of the manipulator. The relative spatial positions of the upper and lower jaws under different working stages were analyzed, demonstrating that the manipulator satisfied the grasping requirements. Through a steel arch splicing experiment, the grasping effect, docking accuracy, and splicing efficiency of the manipulator met the design requirements. The steel arch splicing manipulator can replace the manual completion of the steel arch splicing operation, significantly improving the operation efficiency.

CONTENTS

Vol. 35, No. 2, April, 2022

Intelligent Manufacturing Technology



(2022)35:22
DOI: 10.1186/s10033-022-00694-4

Discriminative Features of Abnormities in a Spiral Groove Gas Face Seal Based on Dynamic Model Considering Contact

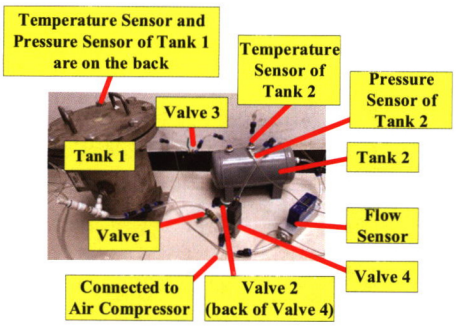
Yuan Yin • Weifeng Huang • Decai Li • Songtao Hu • Xiangfeng Liu • Ying Liu

Abstract: It is a difficult task to root the cause of the failure of a gas face seal because different causes may result in similar observations. In the work being presented, the discrimination of multiple types of abnormities in a spiral groove gas face seal is studied. A dynamic model is employed to analyze groups of cases in order to uncover the dynamic behaviors when the face contact is induced by different mixtures of abnormities, whose discriminative features when motion and contact are monitored are studied and uncovered. A circumferential-pattern-related oscillation phenomenon is discovered, which is extracted from contact information and implies the relative magnitude of the moment on stator and the rotor tilt. The experimental observation shows consistent results. It means that the grooves (or other circumferential patterns) generate useful informative features for monitoring. These results provide guidance for designing a monitored gas face seal system.

(2022)35:44
DOI: 10.1186/s10033-022-00697-1

Gas Leakage Detection and Pressure Difference Identification by Asymmetric Differential Pressure Method

Yan Shi • Jiaqi Chang • Yixuan Wang • Xuelin Zhao • Qingzhen Zhang • Liman Yang



Abstract: Currently, the measurement methods for pneumatic system leakage include bubbling, ultrasonic, and pressure detection methods. These methods are sensitive to high-precision sensors, long detection times, and stable external environments. The traditional differential pressure method involves severe differential pressure fluctuations caused by environmental pressure fluctuations or electromagnetic noise interference of sensors, leading to inaccurate detection. In this paper, a differential pressure fitting method for an asymmetric differential pressure cylinder is proposed. It overcomes the limitation of the detection efficiency caused by the asynchronous temperature recovery of the two chambers in the asymmetric differential pressure method and uses the differential pressure substitution equation to replace the differential calculation of the differential pressure. The improved differential pressure method proposes an innovation based on the detection principle and calculation method. Additionally, the influence of the parameters in the differential pressure substitution equation on the leakage calculation results was simulated, and the specific physical significance of the parameters of the differential pressure substitution equation was explained. The experiments verified the fitting effect and proved the accuracy of this method. Compared with the traditional differential pressure method, the maximum leakage deviation of inhibition was 0.5 L/min. Therefore, this method can be used to detect leaks in air tanks.

CONTENTS

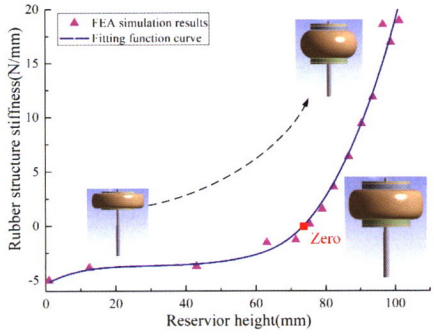
Vol. 35, No. 2, April, 2022

(2022)35:39
DOI: 10.1186/s10033-022-00711-6

Modelling and Dynamic Characteristics for a Non-metal Pressurized Reservoir with Variable Volume

Pei Wang • Jing Yao • Baidong Feng • Mandi Li • Dingyu Wang

Abstract: With the increasing demand to reduce emissions and save energy, hydraulic reservoirs require new architecture to optimize their weight, space, and volume. Conventional open reservoirs are large, heavy, and easily polluted, and threatens the operation of hydraulic systems. A closed reservoir provides the advantages of small volume and light weight, compared to open reservoirs. In this study, a non-metallic pressure reservoir with a variable volume is designed and manufactured for closed-circuit hydraulic systems. The reservoir housing is made of rubber, and the Mooney-Rivlin model is chosen based on the rubber strain properties. The FEA simulation for the reservoir is performed using ANSYS Workbench to obtain the structural stiffness. The major contribution is the establishment of mathematical models for this reservoir, including the volume equation changing with height, flow equation, and force balance equation, to explore the output characteristics of this reservoir. Based on these results, simulation models were built to analyze the output characteristics of the reservoir. Moreover, the test rig of a conventional hydraulic system was transformed into a closed-circuit asymmetric hydraulic system for the reservoir, and preliminary verification experiments were conducted on it. The results demonstrate that the designed reservoir can absorb and discharge oil and a supercharge pump inlet to benefit system operation. The changes in the volume and pressure with displacements under different volume ratios and frequencies were obtained, which verified the accuracy of the mathematical models. Owing to its lightweight design and small volume, the reservoir can replace conventional open reservoirs, and this lays a foundation for future theoretical research on this reservoir.

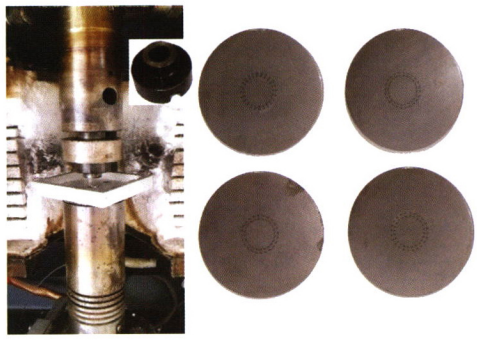


(2022)35:30
DOI: 10.1186/s10033-022-00691-7

Theoretical Analysis and Experimental Research of Surface Texture Hydrodynamic Lubrication

Dan Li • Xuefeng Yang • Yuanbo Wu • Jian Cheng • Shouren Wang • Zhuang Wan • Wenbo Liu • Guofeng Xia

Abstract: The research on surface texture is developing from single macro-texture to composite micro-nano texture. The current research on the anti-friction mechanism and theoretical models of textures is relatively weak. Studying the characteristics of different types of surface textures and determining the applicable working conditions of each texture is the focus of current research. In this paper, a mathematical model of hydrodynamic lubrication is established based on Navier-Stokes equations. The FLUENT software is used to simulate and analyze the four texture models, explore the dynamic pressure lubrication characteristics of different texture types, and provide data support for texture optimization. The key variable values required by the mathematical model are obtained through the simulation data. The friction coefficient of the texture under different working conditions was measured through friction and wear experiments, and the mathematical model was verified by the experimental results. The research results show that circular texture is suitable for low to medium speed and high load conditions, chevron texture is suitable for medium to high speed and medium to high load conditions, groove texture is suitable for high speed and low load conditions, and composite texture is suitable for high speed and medium to high load conditions. Comparing the experimental results with the results obtained by the mathematical model, it is found that the two are basically the same in the ranking of the anti-friction performance of different textures, and there is an error of 10%–40% in the friction coefficient value. In this study, a mathematical model of hydrodynamic lubrication was proposed, and the solution method of the optimal surface texture model was determined.



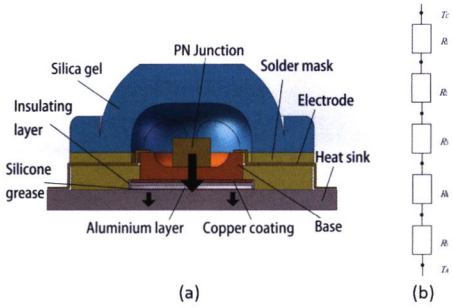
CONTENTS

Vol. 35, No. 2, April, 2022

(2022)35:38
DOI: 10.1186/s10033-022-00704-5

Heat Transfer Performance and Structural Optimization of a Novel Micro-channel Heat Sink

Jianhua Xiang • Liangming Deng • Chao Zhou • Hongliang Zhao • Jiale Huang • Sulian Tao

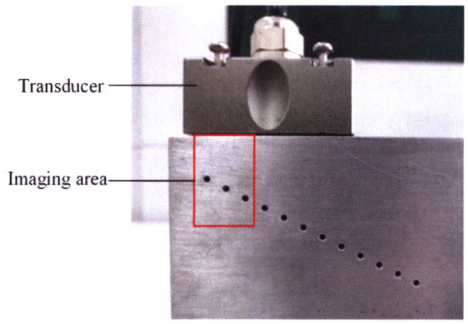


Abstract: With the advent of the 5G era, the design of electronic equipment is developing towards thinness, intelligence and multi-function, which requires higher cooling performance of the equipment. Micro-channel heat sink is promising for the heat dissipation of super-thin electronic equipment. In this study, thermal resistance theoretical model of the micro-channel heat sink was first established. Then, fabrication process of the micro-channel heat sink was introduced. Subsequently, heat transfer performance of the fabricated micro-channel heat sink was tested through the developed testing platform. Results show that the developed micro-channel heat sink has more superior heat dissipation performance over conventional metal solid heat sink and it is well suited for high power LEDs application. Moreover, the micro-channel structures in the heat sink were optimized by orthogonal test. Based on the orthogonal optimization, heat dissipation performance of the micro-channel radiator was further improved.

(2022)35:19
DOI: 10.1186/s10033-022-00682-8

Simplified Matrix Focusing Imaging Algorithm for Ultrasonic Nondestructive Testing

Xinyu Zhao • Zemin Ma • Jiaying Zhang



Abstract: Full matrix focusing method of ultrasonic phased array has been proved with advantages of good signal-to-noise ratio and imaging resolution in the field of Ultrasonic NDT. However, it is still suffering from the time-consuming data acquisition and processing. In order to solve the problem, two simplified matrix focusing methods are provided in the paper. One provided method is a triangular matrix focusing algorithm based on the principle of reciprocity for the multi-channel ultrasonic system. The other provided method is a trapezoidal matrix focusing algorithm based on the energy weight of the different channel to the focusing area. Time of data acquisition and computational is decreased with the provided simplified matrix focusing methods. In order to prove the validity of two provided algorithms, both side-drilled holes and oblique cracks are used for imaging experiments. The experimental results show that the imaging quality of the triangular matrix focusing algorithm is basically consistent to that of the full matrix focusing method. And imaging quality of the trapezoidal matrix focusing algorithm is slightly reduced with the amount of multi-channel data decreasing. Both data acquisition and computational efficiency using the triangular matrix focusing algorithm and the trapezoidal matrix focusing algorithm have been improved significantly compared with original full matrix focusing method.

CONTENTS

Vol. 35, No. 2, April, 2022

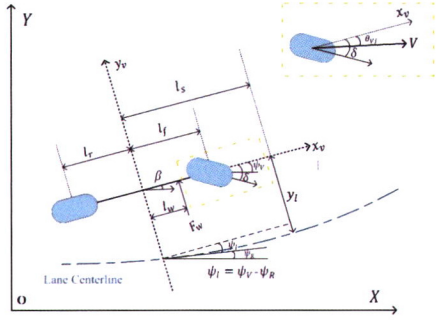
Advanced Transportation Equipment

(2022)35:46
DOI: 10.1186/s10033-022-00706-3

A Type-2 Fuzzy Approach to Driver-Automation Shared Driving Lane Keeping Control of Semi-autonomous Vehicles Under Imprecise Premise Variable

Yue Liu • Qing Xu • Hongyan Guo • Hui Zhang

Abstract: The driver-automation shared driving is a transition to fully-autonomous driving, in which human driver and vehicular controller cooperatively share the control authority. This paper investigates the shared steering control of semi-autonomous vehicles with uncertainty from imprecise parameter. By considering driver's lane-keeping behavior on the vehicle system, a driver-automation shared driving model is introduced for control purpose. Based on the interval type-2 (IT2) fuzzy theory, moreover, the driver-automation shared driving model with uncertainty from imprecise parameter is described using an IT2 fuzzy model. After that, the corresponding IT2 fuzzy controller is designed and a direct Lyapunov method is applied to analyze the system stability. In this work, sufficient design conditions in terms of linear matrix inequalities are derived, to guarantee the closed-loop stability of the driver-automation shared control system. In addition, an H_∞ performance is studied to ensure the robustness of control system. Finally, simulation-based results are provided to demonstrate the performance of proposed control method. Furthermore, an existing type-1 fuzzy controller is introduced as comparison to verify the superiority of the proposed IT2 fuzzy controller.

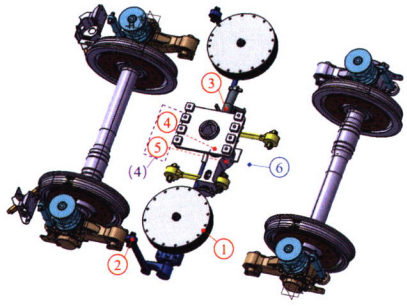


(2022)35:23
DOI: 10.1186/s10033-022-00692-6

Transfer Path Contribution to Floor Vibration of Metro Vehicles Based on Operational Transfer Path Analysis Method

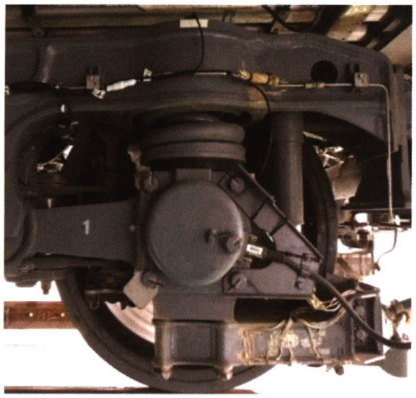
Laixian Peng • Jian Han • Jiaxing Nie • Xinbiao Xiao • Caiying Mi

Abstract: Operational transfer path analysis (OTPA) is an advanced vibration and noise transfer path identification and contribution evaluation method. However, the application of OTPA to rail transit vehicles considers only the excitation amplitude and ignores the influence of the excitation phase. This study considers the influence of the excitation amplitude and phase, and analyzes the contribution of the secondary suspension path to the floor vibration when the metro vehicle runs at 60 km/h, using an analysis based on the OTPA method. The results show that the vertical direction of the anti-rolling torsion bar area provides the maximum contribution to the floor vibration, with a contribution of 22.1%, followed by the longitudinal vibration of the air spring area, with a contribution of 17.1%. Based on the contribution analysis, a transfer path optimization scheme is proposed, which may provide a reference for the optimization of the transfer path of metro vehicles in the future.



CONTENTS

Vol. 35, No. 2, April, 2022

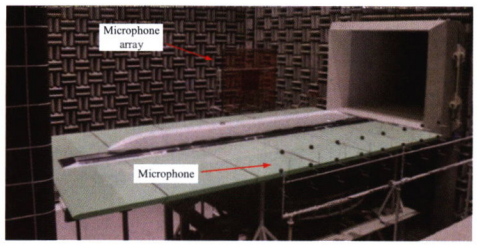


(2022)35:36
DOI: 10.1186/s10033-022-00696-2

Rail Roughness Acceptance Criterion Based on Metro Interior Noise

Xiaolong Liu • Jian Han • Moukai Liu • Jianuo Wang • Xinbiao Xiao • Zefeng Wen

Abstract: Severe rail roughness leads to a series of problems in metro systems, particularly the vehicle noise problem. To ensure a better acoustic environment, rail roughness control is therefore one of the main concerns for the metro operators. But the existing roughness acceptance criteria are not suitable for metro interior noise control. It is an appropriate method to determine the rail roughness limit based on interior noise. A rail roughness acceptance criterion based on metro interior noise is accordingly proposed in this paper. The relationship between rail roughness and interior noise can be derived with wheel-rail noise as link. With this objective, a combined test and simulation method is adopted. A validated wheel-rail noise prediction model is thus established to determine the relationship between rail roughness and wheel-rail noise. Moreover, the transfer function of wheel-rail noise to interior noise is developed based on extensive field test. Using this method, the noise sensitivity to roughness wavelength and acceptance criteria at different speeds and track structures are investigated. Finally, an eclectic rail corrugation acceptance criterion on curved track is suggested in consideration of practical application.



(2022)35:28
DOI: 10.1186/s10033-022-00705-4

Step-by-step Numerical Prediction of Aerodynamic Noise Generated by High Speed Trains

Tian Li • Deng Qin • Ning Zhou • Weihua Zhang

Abstract: In this paper, the unsteady flow around a high-speed train is numerically simulated by detached eddy simulation method (DES), and the far-field noise is predicted using the Ffowcs Williams-Hawkings (FW-H) acoustic model. The reliability of the numerical calculation is verified by wind tunnel experiments. The superposition relationship between the far-field radiated noise of the local aerodynamic noise sources of the high-speed train and the whole noise source is analyzed. Since the aerodynamic noise of high-speed trains is derived from its different components, a stepwise calculation method is proposed to predict the aerodynamic noise of high-speed trains. The results show that the local noise sources of high-speed trains and the whole noise source conform to the principle of sound source energy superposition. Using the head, middle and tail cars of the high-speed train as noise sources, different numerical models are established to obtain the far-field radiated noise of each aerodynamic noise source. The far-field total noise of high-speed trains is predicted using sound source superposition. A step-by-step calculation of each local aerodynamic noise source is used to obtain the superimposed value of the far-field noise. This is consistent with the far-field noise of the whole train model's aerodynamic noise. The averaged sound pressure level of the far-field longitudinal noise measurement points differs by 1.92 dBA. The step-by-step numerical prediction method of aerodynamic noise of high-speed trains can provide a reference for the numerical prediction of aerodynamic noise generated by long marshalling high-speed trains.

CONTENTS

Vol. 35, No. 2, April, 2022

Ocean Engineering Equipment

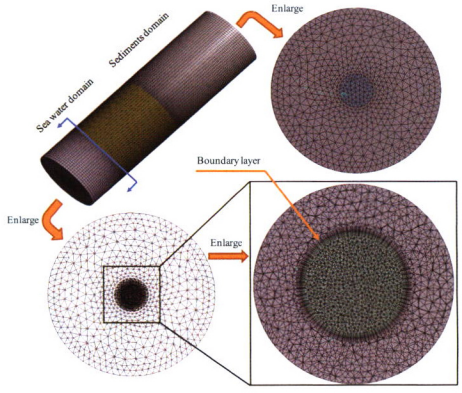
(2022)35:41

DOI: 10.1186/s10033-022-00715-2

Simulated and Experimental Study of Seabed Sediments Sampling Parameters Based on the VOF Method

Shudong He • Youduo Peng • Yongping Jin • Jian Yan • Buyan Wan

Abstract: Sediments in the seabed hold vital clues to the study of marine geology, microbial communities and history of ocean life, and the remote operated vehicle (ROV) mounted tubular sampling is an important way to obtain sediments. However, sampling in the seabed is a particularly difficult and complicated task due to the difficulty accessing deep water layers. The sampling is affected by the sampler's structural parameters, operation parameters and the interaction between the sampling tube and sediments, which usually results in low volume and coring rate of sediments obtained. This paper simulated the soft viscous seabed sediments as non-Newtonian Herschel-Bulkley viscoplastic fluids and established a numerical model for the tubular sampling based on the volume of fluid (VOF) method. The influence rules of the sampling tube diameter, drainage area rate, penetration velocity, and sediments dynamic viscosity on coring rate and volume were studied. The results showed that coring volume was negatively correlated with all the parameters except the sampling tube diameter. Furthermore, coring rate decreased with increases in penetration velocity, drainage area rate, and sediments dynamic viscosity. The coring rate first increased and then decreased with increasing of the sampling tube diameter, and the peak value was also influenced by penetration velocity. Then, based on the numerical simulation results, an experimental sampling platform was set up and real-world sampling experiments were conducted. The simulation results tallied with the experimental results, with a maximum absolute error of only 4.6%, which verified that the numerical simulation model accurately reflected real-world sampling. The findings in this paper can provide a theoretical basis for facilitating the optimal design of the geometric structure of the seabed sediments samplers and the parameters in the sampling process.



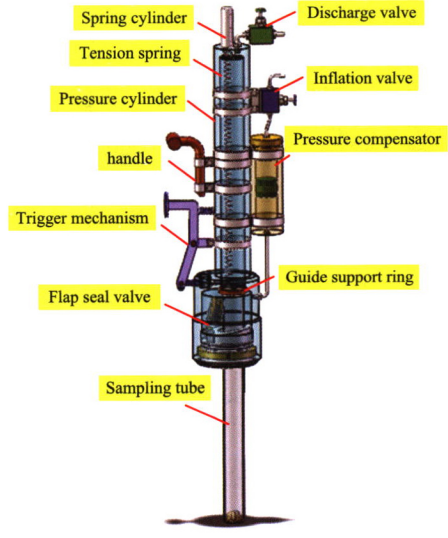
(2022)35:25

DOI: 10.1186/s10033-022-00687-3

Design and Experimental Study of Pressure Compensation System for Full-Ocean-Depth Gas-Tight Sediment Sampler

Guangping Liu • Yongping Jin • Youduo Peng • Buyan Wan

Abstract: Aiming at the requirement of the full-ocean-depth (operating water depth 11000 m) manned submersible to carry out the gas-tight sampling operation of the abyss seabed sediment, a kind of full-ocean-depth carrier submersible mechanical hand-held, full-ocean-depth gas-tight sediment sampler (GTSS) with the function of pressure-retaining and coring is designed. Firstly, the volume change model of pressure compensator is established, and it is pointed out that the volume of pressure compensator is about 16.14% equal to the volume of gas-tight sediment sampler (GTSS). Secondly, the pressure compensator is analyzed and calculated, and the relationship between the precharge pressure of the pressure compensator, the nominal volume of the pressure compensator and the pressure holding effect of the gas-tight sediment sampler (GTSS) is studied. The results show that with the increase of gas precharge pressure in the pressure compensator, the final pressure of the sampler also increases. Under the same precharge pressure condition, the larger the nominal volume of the pressure compensator, the greater the final pressure of the sampler. Finally, the air tightness test method is designed by using the developed gas tightness sampler of the full-ocean-depth product, and the change of the final pressure in the gas tight sampler under different precharge pressure is observed. The test results are consistent with the simulation results, indicating the correctness of the pressure compensation system (PCS) model.



CHINESE JOURNAL OF MECHANICAL ENGINEERING

中国机械工程学报

(Bimonthly, Started in 1988)

Vol. 35, No. 2, April 2022

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 Baochang Color Printing Co., Ltd.

Subscriptions in China Post Offices throughout China
Postal Code: 2-377
Subscription Price in China: ¥ 150

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

9 771000 934220 04>