ISPMM 2015

THE 7th INTERNATIONAL SYMPOSIUM ON PRECISION MECHANICAL MEASUREMENTS

August 7-12, 2015
Xia'men, Fujian, China

Sponsored by

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SPIE
Optics and Precision Engineering

Introduction

Precision is the basis of the manufacturing. With the development of science and technology and the improvement of the requirements in manufacturing, precision engineering are becoming highly multidisciplinary, which covers mechanical, electrical, optical, control and information disciplines. The new methods, new technology and new equipment for measurement are developing faster as well as the development of innovative manufacturing. The micro and nano metrology becomes practice and the requirement of traditional measurements including length, angular, coordinate, vibration and other physics parameters is calling for the new technology. Under this background, We have successfully held six sessions of International Symposium on Precision Mechanical Measurement (ISPMM), the subject and the major topics included length and angular measurement, Coordinate Measurement Technology, Micro-Nano Metrology and MEMS, Sensor Technology and Application, Online Automatic Measurement and Control Vibration, Stress and Thermal Measurement, Opto-Electronic Measurement and Image Processing, Measurement Signal Analysis and Processing, Precision Theory and Uncertainty Evaluation, Quality Engineering Theory and Technology and so on. The 7th ISPMM conference will be held in Xia'men on August 8-12, and the theme of the conference is "New century, new technology and new development". More than 150 manuscripts have been submitted to our conference, and over 200 registered delegates will participate in the conference.

Yetai Fei

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Session Chairs

Session 1：Micro-Nano Metrology & MEMS

Dr. G.L. Dai, The Physikalisch-Technische Bundesanstalt, (Germany)

Prof. K.C. Fan, National Taiwan University, (Taiwan, China)

Session 2：Coordinate Measurement Technology

Prof. A. Asundi, Nanyang Technological University, (Singapore)

A/Prof. E. Peiner, Braunschweig University of Technology, (Germany)

Session 3：Sensor Technology & Application

Prof. M. Gu, Swinburne University of Technology, (Australia)

Prof. S.Y.Liu, Huazhong University of Science and Technology, (China)

Session 4: Three Dimensional Optical Measurement and the Image Signal Processing

Prof. L.X. Yang, Oakland University, (USA)

Dr. Y.H. Huang, SHENZHEN ORBBEC CO.,LTD.(China)

Session 5：Online Automatic Measurement & Control

Prof. S.W. Kim, Korea Advanced Institute of Science and Technology, (Korea)

Prof. X.R. Xu, University of Science and Technology of China, (China)

Session 6：Vibration, Stress & Thermal Measurement

Prof. H.X. Deng, Hefei University of Technology (China)

Prof. C.C. Cui, Huaqiao University, (China)

Session 7：Optical Metrology: Image Processing

Prof. L.Q. Zhu, Beijing Info. Sci. & Tech. University, (China)

Prof. M.Chang, Chung Yuan Christian University, (Taiwan, China)

Session 8：Measurement Signal Analysis & Processing

Prof. D. Wu, University of Science and Technology of China, (China)

Prof. W.H. Zhou, Chinese Academy of Science, (China)

Session 9：Quality Engineering & Uncertainty Evaluation

Prof. Y.H. Wang, Hefei University of Technology, (China)

A/Prof. L.B. Kong, Hongkong Polytechnic University, (Hongkong, China)

Session 10：Optical Metrology: Optical Probe & System

Prof. B.Y. Chen, Zhejiang Sci-Tech University, (China)

Prof. R.S. Lu, Hefei University of Technology, (China)

The 7th ISPMM 2015

Schedule in Summary

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(Hotel lobby)</td><td>08:00-08:30</td><td>Registration</td><td>Secretariat</td><td>08:00-08:30</td><td>Registration</td><td>Secretariat</td><td rowspan="15">Post-Symposium technical tour</td></tr>
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<tr><td>10:40-10:50</td><td>Coffee Break</td><td>Corridor of Room A</td><td rowspan="2">10:20-12:00</td><td rowspan="2">Oral Session</td><td rowspan="2">Room B/C/D</td></tr>
<tr><td>10:50-12:20</td><td>Keynote Speeches 3&4</td><td>Room A</td></tr>
<tr><td>12:00-13:30</td><td>Lunch
Jingdu Tang C /京都堂 C 厅</td><td>12:30-14:00</td><td>Lunch</td><td>Yabo Yuan /雅博园</td><td>12:00-14:00</td><td>Lunch</td><td>Yabo Yuan /雅博园</td></tr>
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<tr><td>16:50-18:00</td><td>Poster Session</td><td>17:10-18:00</td><td>Poster Session</td></tr>
<tr><td>18:00-20:30</td><td>Dinner
Jingdu Tang C /京都堂 C 厅</td><td>18:30-20:30</td><td>Dinner</td><td>Yabo Yuan</td><td>18:30-20:30</td><td>Banquet</td><td>To be notified</td></tr>
<tr><td colspan="3" rowspan="3">Time for presentation
(including the question-and- answer period)</td><td colspan="2">Keynote Speech</td><td colspan="3">45 min</td></tr>
<tr><td colspan="2">Invited Talk</td><td colspan="3">25 min+5 min</td></tr>
<tr><td colspan="2">Oral Presentation</td><td colspan="3">15 min+5 min</td></tr>
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The 7th ISPMM 2015
Keynote Speeches

Date and time		No.	Title	Speaker	Organization	Chair	Room
Aug.8	09:10-09:55	Keynote Speech 1	i-photonics: Age of Nanoscales	Prof. M. Gu	Swinburne University of Technology, (Australia)	Prof. K.C. Fan	Room A
	09:55-10:40	Keynote Speech 2	Computational Imaging for Precision Metrology	Prof. A. Asundi	Nanyang Technological University(Singapore)		
	10:50-11:35	Keynote Speech 3	Applications of Digital Image Correlation Technique in the Measurement of Deformation of Solids for Multi-Scale and Multi-Field Problems	Prof. C.C. Ma	National Taiwan University, (Taiwan, China)	Prof. Y.S. Gao	
	11:35-12:20	Keynote Speech 4	Ultrashort Lasers for Precision Engineering - New Possibilities in Nano/Macro Machining and Metrology	Prof. Seung-Woo Kim	Korea Advanced Institute of Science and Technology, (Korea)		

Oral Session Topics and Chairmen

Date and time		Session No.	Topic	Chairman	Room No.	Present. mount
Aug. 8	14:30-17:30	Session 1	Micro/Nano Coordinate Measurement	Prof. K.C. Fan Dr. G.L. Dai	Room B	7
		Session 2	Coordinate Measurement Technology	Prof. A. Asundi A/Prof. E. Peiner	Room C	7
		Session 3	Sensor Technology & Application	Prof. M. Gu Prof. S.Y. Liu	Room D	7
		Session 4	Three Dimensional Optical Measurement and the Image Signal Processing	Prof. L.X. Yang Dr. Y. H. Huang	Room E	7
Aug. 9	8:30-12:00	Session 5	Online Automatic Measurement & Control	Prof. S.W. Kim Prof. X.R.Xu	Room B	7
		Session 6	Vibration, Stress & Thermal Measurement	Prof. C.C. Cui Prof. H.X. Deng	Room C	7
		Session 7	Optical Metrology: Image Processing	Prof. L.X. Zhu Prof. M. Chang	Room D	7
	14:30-17:30	Session 8	Measurement Signal Analysis & Processing	Prof. D. Wu Prof. W.H. Zhou	Room B	7
		Session 9	Quality Engineering & Uncertainty Evaluation	Prof. Y.H. Wang A/Prof. L.B. Kong	Room C	7
		Session 10	Optical Metrology: Optical Probe & System	Prof. B.Y. Chen Prof. R.S. Lu	Room D	7

Keynote Speakers

Professor Gu is a Laureate Fellow of the Australian Research Council as well as is Pro Vice-Chancellor (Research Capacity), Director of the Centre for Micro-Photonics and University Distinguished Professor at Swinburne University of Technology. He is a sole author of two standard reference books and has over 400 publications in nano/biophotonics. He is an elected Fellow of the Australian Academy of Science as well as the Australian Academy of Technological Sciences and Engineering. He is also an elected fellow of the AIP, the OSA, the SPIE, the InstP, and the IEEE. He was President of the International Society of Optics within Life Sciences, Vice President of the Bureau of the International Commission for Optics (ICO) (Chair of the ICO Prize Committee) and a Director of the Board of the Optical Society of America (Chair of the International Council). He served on the Young Scientist Prize Committee in Optics of the International Union of Pure and Applied Physics. He was awarded the Einstein Professorship (Chinese Academy of Science, 2010) and the W. H. (Beattie) Steel Medal of the Australian Optical Society (2011). He was the recipient of the 2014 Ian Wark Medal and Lecture of the Australian Academy of Science.

Anand Asundi graduated from the Indian Institute of Technology, Bombay with a B.Tech (Civil Engg.) and a M.Tech (Aeronautical Engg.). Subsequently he received his Ph.D. from the State University of New York at Stony Brook. Following a brief tenure at Virginia Tech., he was with the University of Hong Kong from 1983 to 1996 as Professor in the Department of Mechanical Engineering. He is currently Professor in the School of Mechanical and Aerospace Engineering and Director of the Centre for Optical and Laser Engineering at the Nanyang Technological University in Singapore. His current research interests are in Photomechanics, High Resolution Optical Metrology, 3D Imaging, Measurement and Display and bio-chemical Sensing and Imaging. He has published extensively and presented invited seminars/talks at various institutions and at international conferences. He is Editor of Optics and Lasers in Engineering and Fellow of SPIE, the International Society of Optical Engineers and Institution of Engineers, Singapore and member of the Optical Society of America. He is founding chair of the Optics and Photonics Society of Singapore, Asian Committee on Experimental Mechanics and the Asia Pacific Committee on Smart Materials and Nanotechnology. He has organized numerous conferences and served on the Membership, Scholarship/Awards and Presidential Asian Advisory committees of SPIE and on the Board of Directors of SPIE.

Chien-Ching Ma received the B.Sc. degree from National Taiwan University in 1978, M.Sc. degree from Brown University in USA in 1982, and Ph.D. degree from Brown University in USA in 1984. He is the lifetime distinguished professor and Zhong-Juo Zhang Chair in the Department of Mechanical Engineering of National Taiwan University (NTU). He received three times of Outstanding Research Awards and Distinguished Research Fellow Awards from National Science Council of Taiwan, Sun Fan-Tou Gold Medal from Chinese Society of Mechanics, Distinguished Engineering Professor from The Chinese Society of Engineers and Distinguished Engineering Award from the Chinese Society of Mechanical Engineers.

His research interests include Dynamic fracture mechanics, Solid mechanics, Elastic wave propagation, Piezoelectric material, Nondestructive evaluation of materials, Optical measurement, Fiber grating sensor, Multi-field Analysis, Surface acoustic waves, Digital image correlation, Functionally graded material. He has published more than 200 journal papers and 200 conference papers. He is the fellow of ASME, CSME and CSM.

Prof. Seung-Woo Kim is the Dean of the School of Mechanical, Aerospace and System Engineering at Korea Advanced Institute of Science and Technology. He received PhD in precision engineering from Cranfield University (UK) in 1984. He is currently in charge of the graduate research group of Precision Engineering & Metrology. His research interest includes ultrafast optics for ultraprecision machine design, dimensional metrology, and opto- mechatronics systems synthesis. During last two decades of research work, he has published about one hundred technical papers in international journals and conferences. He has been working as principal investigator for numerous national and industrial research projects and currently involved in an important national creative research initiative project for the development of next generation precision engineering key technologies. He has also actively been involved in international academic societies for organizing on-time conferences for leading-edge precision engineering technologies. He is a member of SPIE, OSA, euspen and ASPE.

Oral Sessions 1, Aug. 8, 14:30-17:30			
Oral Session 1 Room B	**Topic**	**Micro-Nano Metrology & MEMS**	
	Chairman	***Prof. K.C. Fan and Dr. G.L. Dai***	
	Time	**Presentation**	**ID**
	14:30-15:00	***Accuracy Improvement of Linear Stages during Assembly (Invited Talk)*** Kuang-Chao Fan, National Taiwan University, Taiwan, China	
	15:00-15:20	***The Research Progress of Metrological 248nm Deep Ultraviolent Microscope Inspection Device*** Wang Zhi-xin[a,b], Li Qi[b], Gao Si-tian[b],Shi Yu-shu[b], Li Wei [b], Li Shi[b] a. China Jiliang University, China b. National Institute of Metrology, China	C107
	15:20-15:40	***Development of a Low-Cost Mini Environment Chamber for Precision Instrument*** Jian Feng[a], Rui-Jun Li[a*], Ya-Xiong He[a], Kuang-Chao Fan[a, b] a. Hefei University of Technology, China b.National Taiwan University, Taiwan, China	J152
	15:40-16:00 Coffee break		
	16:00-16:30	***Traceable 3D advanced nanometrology (Invited Talk)*** Dr. Gaolian Dai The Physikalisch-Technische Bundesanstalt, Germany	
	16:30-16:50	***Mueller matrix ellipsometry with scatterfield tomography for nanostructure metrology*** Weichao Du, Yinyin Tan, Xiuguo Chen, Jiang Hao, Chuanwei Zhang, Shiyuan Liu * Huazhong University of Science and Technology, China	G063
	16:50-17:10	***Shearing interference microscope with phase-shifting and phase–scanning measurement modes*** Shyh-Tsong Lin* and Hưng-Xuân Trịnh National Taipei University of Technology, Taiwan, China	C115
	17:10-17:30	***Using Digital Image Correlation for Full-field Measurement of Carbon Fiber Composite under tensile test*** Ching-Yuan Chang [a] , Chien-Ching Ma[b] [a]National Taipei University of Technology, Taiwan, China [b]National Taiwan University, Taiwan, China	G-116

Oral Sessions 2, Aug. 8, 14:30-17:30			
Oral Session 2 Room C	**Topic**	**Coordinate Measurement Technology**	
	Chairman	***Prof. A. Asundi and A/Prof. E. Peiner***	
	Time	**Presentation**	**ID**
	14:30-15:00	***Piezoresistive microcantilevers for industrial micro/nanoscale sensing applications*** A/Prof. E. Peiner Braunschweig University of Technology, Germany	
	15:00-15:20	***Kinematic Modeling and Verification of an Articulated Arm Coordinate Measuring Machine*** Huaishan Zhang, Guanbin Gao*, Jing Na, Xing Wu Kunming University of Science and Technology, China	B-021
	15:20-15:40	***Study on The Three-Station Typical Network Development of a micro-CMM with Five-axis Scanning Touch Probe*** Chih-Liang Chu*, Hung-Chi Chen Southern Taiwan University of Science and Technology, Taiwan, China	B-117
	15:40-16:00 Coffee Break		
	16:00-16:20	***The micro-sized internal structure in acoustic image by 3D impulse Scanning Acoustic Microscopy*** Jinwen Ding*[a], Kang Li[b], Ning Li[c], Guochao He[a], Qingping Zhang[a] a. University of Science and Technology of China, China b. Anhui Province Coal Science Research Institute, China	C-065
	16:20-16:40	***Development of a cost-effective precision force actuator for deformable mirror active optics*** Dehua Yang[a]， Gang Cheng[b] [a] Nanjing University of Aeronautics and Astronautics, China; [b] China University of Mining and Technology, China	D-034
	16:40-17:00	***Focus Variation as a new technology for industrial metrology*** Mr.Arno Zaworka Alicona Imaging GmbH, Austria	

	17:00-17:20	***Design and Simulation of a Novel Impact Piezoelectric Linear-Rotary Motor*** Liling Han, Yahui Zhao, Chengliang Pan, Liandong Yu* School of Instrument Science and Opto-electronics Engineering, Hefei University of Technology, Hefei, Anhui 230009, China	F-170

Oral Sessions 3, Aug. 8, 14:30-17:30

Oral Session 3 Room D	**Topic**	**Sensor Technology & Application**	
	Chairman	***Prof.M.Gu and Prof. S.Y. Liu***	
	Time	**Presentation**	**ID**
	14:30-15:00	***Defect depth measurement of Carbon Fiber Reinforced Plastic by thermography (Invited Talk)*** Terry Yuan-Fang Chen [a] National Cheng Kung University, Taiwan, China	
	15:00-15:20	***A dynamic calibration method for the pressure transducer*** Wang Zhongyu*, Wang Zhuoran, Li Qiang Beihang University, China	D-005
	15:20-15:40	***Discussion on the absolute calibration of piezoelectric acoustic emission sensors*** He Longbiao[*a], Wang Yuying[b], Zhu Haijiang[b], Yang Ping[a] a. National Institute of metrology, China b. Beijing University of Chemical technology, China	D-109
	15:40-16:00 Coffee Break		
	16:00-16:30	***Expanding quantitative phase measurement of differential interference contrast system using water-immersion technique(Invited Talk)*** Shih-Chieh Lin National Tsing Hua University, Taiwan, China	
	16:30-16:50	***Multi-sensor Data Fusion Method for Measurement of Complex Freeform Optics*** M.J. Ren[*a], M.Y. Liu[b], C.F. Cheung[b], Y.H. Yina [a]. a. Shanghai Jiao Tong University, China; [b]. The Hong Kong Polytechnic University, Hongkong, China	B-044
	16:50-17:10	***The impacts of carrier-envelope-offset frequency in dual-comb ranging system*** Guanhao Wu[a*], Luofeng Shen[a,b], Kai Ni[b*], Xianghui Zeng[a,b], Zebin Zhu[a] a. Tsinghua University, China; b. Graduate School at Shenzhen, Tsinghua University , China	H-038

	17:10-17:30	***Research on A Precise Different Box-Counting Method of Eliminating Image Background*** Kexue-LAI, Tao-HE, Cancan-LI,Lang-CHEN, Liangen-YANG Hubei University of Technology, China	G-164

Oral Sessions 4, Aug. 8, 14:30-17:30			
Oral Session 4 Room E	**Topic**	**Three Dimensional Optical Measurement and the Image Signal Processing**	
	Chairman	***Prof. L.X. Yang and Dr. Y.H. Huang***	
	Time	**Presentation**	**ID**
	14:30-15:00	***Consumer Level Depth Sensing - Today and Tomorrow (Invited Talk)*** Yuanho Huang Shenzhen Orbbec Co., China	
	15:00-15:20	***Correlation in frequency domain based on 2DCWT*** Wei Wei Sun Nanjing University of Aeronautics and Astronautics, China	H-125
	15:20-15:40	***Measuring Method of CCD Installation Verticality Based on Own System of Intelligent Laser Cutting Machine*** Ping ZHONG*, Hongbo LU, Ziyuan CHEN, Pan HE，Xueshi JIANG , Pengfei LI a Donghua University, China	E-135
	15:40-16:00 Coffee Break		
	16:00-16:30	***Review of Advanced Optical Methods for Three Dimensional Displacement and Strain Measurements (Invited Talk)*** Lianxiang, Yang Oakland University, USA	
	16:30-16:50	***Experimental Research of Digital Image Correlation System In High temperature Test*** Li CHEN[a], Yonghong WANG[a]*, Xizuo DAN[a] ,Yifei DING[a], Lianxiang YANG[a,b] a. Hefei University of Technology, China b. Oakland University, USA	G-137

	16:50-17:10	***Response of piezoelectric laminated micro plates under the excitation of an ultrasonic wave*** Xin KANG[a], Shuai DONG[b,c] a. Putian University, China b. Nanjing University of Aeronautics and Astronautics c. Central South University, China	H-138
	17:10-17:30	***A camera array device for short-working-distance image captures*** Xiaoyuan He, Cong Liu, Yingjun Xu, Chengfei Wang Southeast University, China	G-143
Oral Sessions 5, Aug. 9, 08:30-12:00			
Oral Session 4 Room B	**Topic**	**Online Automatic Measurement & Control**	
	Chairman	***Prof. S.W.Kim and Prof. X.R. Xu***	
	Time	**Presentation**	**ID**
	8:30-9:00	***3D printing of tissue-simulating phantoms as a traceable standard for biomedical optical measurement (Invited Talk)*** Xiaorong, Xu University of Science and Technology of China, China	
	9:00-9:20	***Research on Stability of nozzle-floating plate institution*** Huang Bin[a], Tao Jiayue[a], Yi Jiajing[a], Chen Shijing[b] a. Hefei University of Technology, China b. Shengnuo Electronics Technology Co., Ltd., China	D-165
	9:20-9:40	***Development of portable and real-time self-calibration angle encoder*** Yao Huang[a], Zi Xue[*a], Hu Lin[a], Yan Wang[b] a National Institute of Metrology, China b China Jiliang University, China	A-039
	9:40-10:00	***Study on self-calibration angle encoder using simulation method*** Yan Wang[a], Zi Xue [*b], Yao Huang [b,] Xiaona Wanga [b] a Institute of Industry and Trade Measurement Technique in China Jiliang University b National Institute of Metrology, China	D-127
	10:00-10:20 Coffee Break		

	10:20-10:40	***A Novel Double-Ball-Bar with Two Spatial Linkages and One Spherical Joint*** Zhu Yewen, Wang Wen*, Zhang Min, Lu Keqing, Fan Zongwei, Shi Guang Hangzhou Dianzi University, China	I-082
	10:40-11:00	***Automatic flatness detection system for micro part*** Yi Luo*, Xiaodong Wang, Zhendong Shan, Kehong Li Key laboratory for Micro/Nano Technology and System of Liaoning Province, Dalian University of Technology, China	J-085
	11:00-11:20	***Blade synchronous vibration measurement based on tip-timing at constant rotating speed without once-per revolution sensor*** Guo Haotian[a]， Duan Fajie[*a]， Wang Meng[a] aTianjin University State Key Laboratory of Precision Measuring Technology and Instruments Tianjin, China	F-153
	11:20-11:40	***Effect of Surface Roughness on the Performance of Carbon Nanotube Array Thermal Interface Material*** Mengyu Wang, Yang Zhao University of Science and Technology of China, China	F130
	11:40-12:00	***CFD simulation and optimization of the capillary throttling of air-flotation unit*** Huang, B.[a], Yi, J.J.[a], Tao, J.Y.[a], Lu, R.S.[a] a Hefei University of Technology,China	E-106

Oral Sessions 6, Aug. 9, 08:30-12:00

Oral Session 5 Room C	**Topic**	**Vibration, Stress & Thermal Measurement**	
	Chairman	***Prof. C.C. Cui, and Prof. H.X. Deng***	
	Time	**Presentation**	**ID**
	8:30-9:00	***Techniques of Measurement and Characterisation of Grinding Wheel Surface Topography (Invited Talk)*** Changcai Cui Huaqiao University, China	
	9:00-9:20	***Analysis of automobile engine cylinder pressure and rotation speed from engine body vibration signal*** Wang Yuhua[*a], Cheng Xianga, Tan Haishua a Foshan University, China	F-003

	9:20-9:40	***Torsional piezoceramic resonators for viscosity measurement of Newtonian fluids*** Chengliang Pan School of Instrument Science and Opto-electronics Engineering, Hefei University of Technology, China	
	9:40-10:00	***A Circuit Processing Method for Restraining DC Drift for Interferometry of Micro Vibration*** Hao Hou[*a], Xuanze Wang [a], Zhongsheng Zhai [a] a Hubei University of Technology,Chinaa	F-010
	10:00-10:10 Coffee break		
	10:10-10:40	***A Noncontact Dynamic Measurement Method and its Uncertainty Evaluation (Invited Talk)*** Huaxia Deng Hefei University of Technology, China	
	10:40-11:00	***Self-powered semi-passive vibration damping system based on self-sensing approach*** Hui Shen[*a], Fengsheng Zhang[a], Hongli Ji[b], Jinhao Qiu[b], Yixiang Bian[c] a Qingdao University, Qingdao, China; bNanjing University of Aeronautics & Astronautics, China; c Yangzhou University, China	F-155
	11:00-11:20	***Modal Testing and Vibration Analysis of a 50kW DC Motor Structure*** Tien-Tung Chung[*a], Yan-Zuo Chena, Ka-Weng Chua, Ta-Chuan Liu[b] a National Taiwan Univ., Taiwan, China; b Industrial Technology Research Institute, Taiwan, China	F-113
	11:20-11:40	***The Design of an Energy Harvesting Device for Prolonging the Working Time of DC Equipment*** Yayuan Wen, *Huaxia Deng, *Jin Zhang, Liandong Yu Hefei University of Technology, China	J146
	11:40-12:00	***The Precision Study of Mark Position after Binarization for Dynamic Tests*** Guoce Hu, Jin Zhang*, Huaxia Deng*, Liandong Yu Hefei University of Technology, China	G168

Oral Session 7, Aug. 9, 08:30-12:00

Oral Session 6 Room D	**Topic**	**Optical Metrology: Image Processing**	
	Chairman	***Prof. L.Q. Zhu and Prof. M. Chang***	
	Time	**Presentation**	**ID**

	8:30-9:00	***High-resolution optical inspection system for fast detection and classification of surface defects (Invited Talk)*** Ming Chang, Chung Yuan Christian University, Taiwan, China	
	9:00-9:20	***High precision absolute distance measurement with the fiber femtosecond optical frequency comb*** Jiashuai Guo,Tengfei Wu, Zhiguo Liang，Yu Wang and Jibo Han Beijing Changcheng Institute of Metrology & Measurement	B-056
	9:20-9:40	***Precise Positioning Method for Multi-process Connecting Based on Binocular Vision*** Wei Liu, Lichao Ding, Kai Zhao, Xiao Li, Ling Wang, Zhenyuan Jia School of Mechanical Engineering, Key Laboratory for Precision and Non-traditional Machining Technology of the Ministry of Education, Dalian University of Technology	E-041
	9:40-10:00	***Study on hologram mosaic algorithm based on Harris corners*** Jiabao Yao, Qiuhong Tian, Zhengrong Sun, Liu Huang, Limin Wang Zhejiang Sci-Tech University	G-122
	10:00-10:10 Coffee break		
	10:10-10:40	***Narrow-linewidth fiber laser based on all-fiber filtering techniques(Invited Talk)*** Lianqing Zhu Beijing Information Science and Technology University, China	
	10:40-11:00	***Structural Optimization Design on Pneumatic Sensor with Large Measurement Range*** Bi Du, Yong Zhang, Rong-sheng Lu, Liang Xiao Hefei University of Technology, China	A-110
	11:00-11:20	***Digital Image Correlation based Residual Thermal Strain Measurement Using Laser Hole Drilling*** Chao-Ching Ho[*a], G.-H.Leea, Yuan-Jen Chang[a], Jin-Chen Hsua, Chia-Lung Kuo[a], S.-K.Kuo[b] a National Yunlin University of Science and Technology, Taiwan, China ; b Iron and Steel Research and Development Department, Taiwan, China	G-059
	11:20-11:40	***Multi-Cameras Calibration from Spherical Targets*** Chengyun Zhao, *Jin Zhang, *Huaxia Deng, Liandong Yu Hefei University of Technology, China	G150
	11:40-12:00	***A Calibration Technology for multi-camera system with various focal lengths*** Ruihua Yang, *Jin Zhang,*Huaxia Deng, Liandong Yu Hefei University of Technology, China	G145

Oral Sessions 8, Aug. 9, 14:30-17:30			
Oral Session 7 Room B	**Topic**	**Measurement Signal Analysis & Processing**	
	Chairman	***Prof. D.Wu and Prof. W.H. Zhou***	
	Time	**Presentation**	**ID**
	14:30-15:00	***In-channel integration of 2D-3D designable microoptical devices for coupling-free optofluidic cell counting (Invited Talk)*** Dong Wu University of Science and Technology of China, China	G-070
	15:00-15:20	***Modeling and analysis of magnetic field distribution of Square Pane Permanent Magnet in Intelligent Ball Hinge*** Zhu Liang , Hu Penghao , Yang Wenguo , Ma Xiaoqing , Dang Xueming Hefei University of Technology,China	A-011
	15:20-15:40	***Measurements of Interfacial Heat Flux for Accurate Numerical Simulations of A Liquid Impinging Thermoelectric Cooler (LITEC)*** Kuan Sung Hsua, Mark Christian E. Manuela, Po Ting Lin[*a], Yan-Ru Peng[a] a Chung Yuan Christian University,Taiwan, China	F-119
	15:40-16:00 Coffee break		
	16:00-16:30	***Research on Femtosecond Laser Measurement Technology (Invited Talk)*** Weihu Zhou Chinese Academy of Science, China	
	16:30-16:50	***Noise Analysis of Infrared Touch Screen and its Application on Kalman Filter*** Aiguo ZHOU[a], Qiangbiao PAN[a], Shuyi CHENG[b] a. Tongji University, China b. Shanghai Tech University, China	H-136
	16:50-17:10	***Weak Signal Detection based on the New Fractional Order Bistable System*** Yongjun ZHENG, Cong ZHANG, Zengxian ZHU, Fei WANG China Jiliang University, China	H-134
	17:10-17:30	***Study on evaluation methods of the gear pitch deviations based on statistical analysis*** X. Y. WANG[a,b], Z. Y. SHI*[a], Z. H. SHU[a], J. TANG[a] a Beijing University of Technology,China; b Henan University of Science and Technology, China;	I-154

Oral Sessions 9, Aug. 9, 14:30-17:30			
Oral Session 8 Room C	**Topic**	**Quality Engineering & Uncertainty Evaluation**	
	Chairman	***Prof. Y.H. Wang, and A/Prof. L.B. Kong***	
	Time	**Presentation**	**ID**
	14:30-15:00	***Development of 3D Dynamic Measurement by Digital Speckle Technique (Invited Talk)*** Y.H. Wang Hefei University of Technology,China	A-018
	15:00-15:20	***Measurement system and precision analysis for bending and twisting properties evaluation of textile fabrics*** Yao Bao-guo[a *], Zhang Shan[a], Yang Yun-juan[a], Zhang De-pin[a] a Jiliang University, China	I-103
	15:20-15:40	***Precision evaluation of calibration factor of a superconducting gravimeter using an absolute gravimeter*** FENG Jin-yang[a], WU Shu-qing, LI Chun-jian, SU Duo-wu, XU Jin-yi, YU Mei a National Institute of Metrology,China	I-104
	15:40-16:00 Coffee Break		
	16:00-16:30	***Measurement and Characterization of Three Dimensional (3D) Microstructures on Precision Roller Surfaces (Invited Talk)*** L.B. Kong [*a,b] [a] Guangdong University of Technology, China, [b] The Hong Kong Polytechnic University, Hongkong, China	
	16:30-16:50	***Uncertainty estimation in form error evaluation of freeform surfaces for precision metrology*** Xiangchao Zhang[a] , Hong Xiao[b], Hao Zhang[a], Xiaoying He[a] and Min Xu[a] a Fudan University, China b. China Academy of Engineering Physics, China	I-002
	16:50-17:10	***The Slider Motion Error Analysis by Positive Solution Method in Parallel Mechanism*** Ma Xiaoqing , Hu Penghao , Zhu Liang ,Yang Wenguo Hefei University of Technology, China	I-015

	17:10-17:30	***Measurement uncertainty evaluation in multi-strategies of CMM*** Li Hongli[a], Chen Xiaohuai[a], Wang Hongtao[a], Yang Qiao[b], Wang Hanbin[a], Cheng Yinbao[a] Hefei University of Technology, China	I-014

Oral Sessions 10, Aug. 9, 14:30-17:30

Oral Session 9 Room D	**Topic**	**Optical Metrology: Optical Probe & System**	
	Chairman	***Prof. B.Y. Chen and Prof. R.S. Lu***	
	Time	**Presentation**	**Abstract ID**
	14:30-15:00	***Automated Optical Inspection for Surface Defects (Invited Paper)*** RongSheng. Lu Hefei University of Technology, China	
	15:00-15:20	***Influences of pulse on the performance of phase-sensitivity OTDR*** Chunxi Zhang, Xiang Zhong*, Lijing Li Beihang University, China	D-068
	15:20-15:40	***A measurement system for surface topography based on three-wavelength interferometry*** Yang Liangen*, He Lang, Wang Xuanze, Liu Chuang, He Tao Hubei University of Technology; China	B-022
	15:40-16:00 Coffee Break		
	16:00-16:20	***Sub-Pixel Edge Detection of High Temperature Environment Image Using Dual Fitting Algorithm*** Lu Yu[a], Lu Rong-Sheng [*a], Guo Guang-Ping b a. Hefei University of Technology, China b. Beijing Institute of Aeronautical Materials, China	G-071
	16:20-16:40	***Design of automatic optical inspection (AOI) system for flat plate surface defects*** Zhang Tengda，Lu Rongsheng Hefei University of Technology, China	J-029
	16:40-17:00	***Design and Experiment on a Multi-functioned and Programmable Piezoelectric Ceramic Power Supply with High Precision for Speckle Interferometry*** Wang Biao, YE Yan, WANG Yong-hong Hefei University of Technology, China	G-097
	17:00-17:20	***Studies of different error elimination algorithm under defocusing digital fringe projection*** Ji Deng, Huaxia Deng*, Jin Zhang*, Liandong Yu Hefei University of Technology, China	G-148

Abstracts of Papers

I-047

Accuracy Improvement of Linear Stages during Assembly

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ABSTRACT

The accuracy of precision machine is dependent on the geometric errors of each axis. Most researches in the past focused on the measurement and compensation of existing errors. If these errors are already large, any compensation strategy could reduce only a part of total errors. It is known that the geometric errors, including three linear and three angular terms, in each axis are entirely due to improper assembly of the moving stage. If these errors could be reduced during the assembly stage, final volumetric errors of the machine would be largely reduced even without compensation strategy. This paper presents a method of adjusting setting screws of parallel linear guides that support the linear stage. A laser alignment system for measuring two straightness errors with a resolution of 0.1 μm and a laser autocollimator system with a resolution of 0.1 arc-sec for measuring two angular errors are developed to assist the process of the stage assembly. Experimental results show that with a proper adjustment strategy the geometric errors of the linear stage can be significantly reduced after assembly.
Keywords: Geometric errors, Machine tool, Guideway errors, Assembly adjustment.

C-107

The Research Progress of Metrological 248nm Deep Ultraviolent Microscope Inspection Device

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ABSTRACT

In lithography process, the precision of wafer pattern to a large extent depends on the geometric dimensioning and tolerance of photomasks when accuracy of lithography aligner is certain.Since the minimum linewidth (Critical Dimension) of the aligner exposing shrinks to a few tens of nanometers in size, one-tenth of tolerance errors in fabrication may lead to microchip function failure, so it is very important to calibrate these errors of photomasks. Among different error measurement instruments, deep ultraviolent (DUV) microscope because of its high resolution, as well as its advantages compared to scanning probe microscope restrained by measuring range and scanning electron microscope restrained by vacuum environment, makes itself the most suitable apparatus. But currently there is very few DUV microscope adopting 248nm optical system, means it can attain 80nm resolution; furthermore, there is almost no DUV microscope possessing traceable calibration capability. For these reason, the National Institute of Metrology, China is developing a metrological 248nm DUV microscope mainly consists of DUV microscopic components, PZT and air supporting stages as well as interferometer calibration framework. In DUV microscopic component, the Köhler high aperture transmit condenser, DUV splitting optical elements and PMT pinhole scanning elements are built. In PZT and air supporting stages, a novel PZT actuating flexural hinge stage nested separate X,Y direction kinematics and a friction wheel driving long range air supporting stage are researched. In interferometer framework, a heterodyne multi-pass interferometer measures XY axis translation and Z axis rotation through Zerodur mirror mounted on stage. It is expected the apparatus has the capability to calibrate one dimensional linewidths and two dimensional pitches ranging from 200nm to 50μm with expanded uncertainty below 20nm.
Keywords: Photomasks, Critical Dimension, Metrological, DUV microscope

J-152

Development of a Low-Cost Mini Environment Chamber for Precision Instrument

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ABSTRACT

The wavelength of laser interferometer used widely in precision measurement instrument is affected by the refractive index of surrounding air, which depends on the temperature, relative humidity (RH) and air pressure. A low-cost mini chamber based on the natural convection principle with high-precision temperature-controlled and humidity-suppressed is proposed in this paper. The main chamber is built up by acrylic walls supported by aluminum beam column and are tailored according to the required space. A thin layer of vacuum insulation panel (VIP) with an ultralow thermal conductivity coefficient is adhered around the walls so as to prevent heat exchange with room air. A high-precision temperature sensor measuring the temperature near the instrument's measuring point provides a feedback signal to a proportional-integral-derivative (PID) controller. Several thermoelectric coolers uniformly arranged on the ceiling of the chamber to cool the air inside the chamber directly without any air supply system, yielding a vibration-free cooling system. A programmable power supply is used as the driver for the coolers to generate different cooling capacities. The down-flowing cool air and the up-flowing hot air form a natural convection, and the air temperature in the chamber gradually becomes stable and finally reaches the temperature set by the PID controller. Recycled desiccant contained silica gels that have high affinity for water is used as a drying agent. Experimental results show that in about two hours the system's steady state error is 0.003 °C on average, and the variation range is less than ± 0.02 °C when the set temperature is 20 °C, the RH is reduced from 66% to about 48%. This innovative mini chamber has the advantages of low-cost, vibration-free, and low energy-consumption. It can be used for any micro/nanomeasurement instrument and its volume can be customer-designed.
Keywords: Mini Environment Chamber, thermoelectric cooler, natural convection principle, vacuum insulation panel, precision instrument, PID controller.

G-063

Mueller matrix ellipsometry with scatterfield tomography for nanostructure metrology

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ABSTRACT

Since the dimensions of smallest scatterer (grating) details are smaller than the wavelength of the inspection light, conventional imaging techniques are not able to provide sufficient resolution for measurement. As a non-imaging technique, Mueller matrix ellipsometry has been introduced for nanostructure metrology with great success for many years, and it is a powerful tool to retrieve periodic grating structures from diffracted signature of optical far field. However, it only utilizes the zeroth-order diffraction of the sample and reconstructs structural profiles with results averaged over all the structures confined in the illumination spot. In fact, the rest diffraction orders ignored also contain rich information of the sample, which could be used to improve the measurement sensitivity and characterize more structural parameters of the sample. In this paper, we propose a novel optical instrument named Mueller matrix ellipsometer with scatterfield tomography (MEST) which combines the Mueller matrix ellipsometry with the

microscopic technique. A high numerical-aperture objective lens is introduced into MEST to collect more diffracted light. A galvanometer-mounted scanning mirror is used to vary the angle of illumination of the sample. Thus, scatterfield distributions of the sample can be obtained by imaging the back focal plane of the objective under various illuminating incidence angles, and each scatterfield point represented by a 4×4 Mueller matrix is determined by solving at least 16 linearly independent combinations of polarization properties. Therefore, MEST can obtain more diffraction orders of the nanostructure than conventional Mueller matrix ellipsometer and consequently provide much more useful information about the sample. The principles and calibration methods of the MEST are described and the scatterfield distribution measurement process of a grating structure is discussed as an example. The structural profile parameters including the critical dimension linewidth, the grating height and the sidewall angle, are extracted. The experimental results are in good agreement with the theoretical ones, which demonstrates that the MEST has a good potential for nanostructure metrology.

Keywords: Muller matrix ellipsometry, Nanostructure metrology, Tomography, Scatterfield measurement

C-115

Shearing interference microscope with phase-shifting and phase–scanning measurement modes

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ABSTRACT

A shearing interference microscope composed of a polarizer, a beam-splitter, an objective, a sample, a reflecting mirror, two Savart prisms, a rotation stage, an analyser, and a CCD camera is developed in this research. Where the 1stSavart prism, which is placed on the light route toward the objective, laterally splits the incident beam into two beams, the 2ndSavart prism, which is on the light route away from the objective, recombines the split beams,and the recombined beams generate a shearing interference pattern, which carries the information of the contour difference of the sample, on the CCD camera.

Two measurement modes, phase-shifting and phase-scanning, are also developedto manipulate the interference pattern and then retrieve the contour difference; the former, which utilizes a narrow-band source, is available forsmooth surface examinations and the latter, which employs a broad-band source, is capable ofsmooth or piece-wise smooth surface measurements. This paper firstintroduces the measurement theory and a setup for realizing the microscope; it then presents two experiments involving the use of the setup, one for determining the contour difference of a micro-mirre using the phase-shifting mode and the other for measuring the height of a step-height on a silicon substrate using the phase-scanning mode. The results of the experiments confirm the validity andapplicability of the proposedmicroscope.

Keywords: Shearing interference microscope, Phase-shifting,Phase-scanning, Contour difference

B-021

Kinematic Modeling and Verification of an Articulated Arm Coordinate Measuring Machine

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ABSTRACT

The articulated arm coordinate measuring machine (AACMM) is a new type of non-orthogonal coordinate measuring machine (CMM). Unlike the traditional orthogonal CMM which has three linear guides the AACMM is composed of a series of linkages connected by rotating joints. Firstly, the coordinate systems of the AACMM are established according to D-H method, the homogeneous transformation matrixes from the probe to the base of the AACMM are derived. And the graphic simulation system of the AACMM is built in Matlab, which verify the magnitude and direction of the joint angles qualitatively. Then, the data acquisition software of the AACMM is compiled by Visual C++, and there is a statistical analysis on the calculated measuring coordinates and actual coordinates, which indicates that the kinematic model of the AACMM is correct. The kinematic model provides a basis for measurement, calibration and error compensation of the AACMM.
Keywords: articulated arm coordinate measuring machine, kinematics modeling, simulation, experiments

C-065

The micro-sized internal structure in acoustic image by 3D impulse Scanning Acoustic Microscopy

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ABSTRACT

The properties of a solid specimen depend on its elastic property and its microstructures, which are not only in nano size but also in micro-sized scale. Impulse acoustic microscope is a technology, employing a focused ultrasound probe beam in immersion to penetrate into a solid specimen, to detect the internal micro-sized structure by acoustic imaging for a solid bulk material. Acoustic lens produces such probe beam into a specimen and receives response radiations reflected from the specimen. The characters of an acoustic lens determine the precision and quality of acoustical imaging; and the relevant controlling techniques are also important peripheral elements for the system; but, it is ignored or not raised attention, that the acoustic interaction behavior between the focused ultrasound probe beam and an internal micro-sized structure in a bulk - diffraction, scatter phenomena, usually also presents an inevitable impact on acoustic images. The authors try to introduce these principles to demonstrate these factors are the fundamental key, to promote the performance of impulse Scanning Acoustic Microscopy.
Keywords: Impulse scanning acoustic microscope, acoustic Lens, focused beam, acoustical imaging, Three-Dimensional image, diffraction, scatter, signal aberration

B-117

Development of a micro-CMM with Five-axis Scanning Touch Probe

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ABSTRACT

The purpose of this study is to develop with low cost, high precision, low contact force micro-CMM that has five-axis

scanning touch probe. In this study, the measurement performance of the proposed system is enhanced through the use of a rigid aluminum double-arch-bridge structure to support the five-axis scanning touch probe. Furthermore, the reliability of the scanning probe mechanism of three degrees of freedom was analyzed and validated. in addition two axis (A-axis and C-axis) was added on the scanning probe. This design can be achieved independent of measurement, and minimize the dynamic error. In terms of software, a PC-Based controller was integrates five-axis motion systems with the measurement system through a five-axis control card and a data acquisition card. It also completed the functional modules of Set, Manual and Measurement. In the measurement system, we used our own developed coordinate measurement software, with the XYZ platforms system, rotating mechanism and scanning probe to achieve complex surface measurements. The micro-CMM has a working volume the micro-CMM has a working volume of 80 ×80×40 mm3 , and the overall dimensions is 486 × 486 × 448 mm.

Keywords: micro-Coordinate Measuring Machine, Double-arch-bridge structure , Scanning touch probe

F-130

Effect of Surface Roughness on the Performance of Carbon Nanotube Array Thermal Interface Material

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ABSTRACT

Vertically aligned carbon nanotube(CNT) arrays can be used as thermal interface materials by directly establishing thermal contact between two mating solid surfaces. With assistant of indium (In) bonding, it was found that the interface thermal conductance of CNT array can reach 1 MW/m2-K. However, most of the previous work were done with smooth surfaces such as Si or glass wafers. The effect of surface roughness on the interface thermal conduction with CNT arrays has not been discussed thoroughly. Considering real application，engineered Cu is prevalently used as the material for thermal management components, which always contains certain roughness. Therefore,in this work, we systematically study the thermal contact resistance of CNT arrays with surfaces with controlled roughness. The CNT-Cu interfaces are optically measured using phase sensitive thermal reflectance thermometry. The results indicate that the Cu surface roughness does not affect the effective thermal conductivity of CNT arrays significantly, while the Cu-CNT array contact thermal conductance has a strong dependence on the surface roughness and has an order of magnitude drop as the Cu surface roughness approaches the Cr/Au coated CNT array roughness(~0.18 m).The work could provide a guideline to determine the minimum requirement on the surface finishing at interfaces with CNT TIMs and suggests that the target surface roughness is one of the key factors for CNT arrays based TIMs to reach a high thermal conductance.

Keywords: Thermal interface material, Surface roughness, Vertically aligned carbon nanotube array, Contact thermal conductance, Thermal conductivity

G-128

Multi-parameter characterization of a general optical retarder using Mueller matrix ellipsometer

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ABSTRACT

Optical retarders are widely used to modify the polarization states of the polarized light by producing a phase shift

between the two orthogonal polarization components. They are indispensable optical components in many optical systems such as ellipsometry and polarimetry, and their performances affect the accuracy and precision of these optical systems significantly. Therefore, the characterization of the optical properties including the retardance, the transmission amplitude ratio (also known as the dichroism), the fast axis azimuth and the rotary angle of the optical retarders is of great importance. There have been various methods for the characterization of an optical retarder in the published literatures, such as interference methods, laser frequency-splitting methods, time-domain methods and spectroscopic methods. However, most of these methods can only measure one or two characteristic parameters, but fail to provide a full characterization of a general optical retarder. Mueller matrix ellipsometer (MME) has been designed and applied as a powerful tool for the characterization of anisotropic samples by providing a 4×4 Mueller matrix of the sample in each measurement. Thus, the MME has the capability and advantages in the characterization of an optical retarder that can be treated as a typical anisotropic sample. In this paper, we propose a method to fully characterize a general optical retarder over a broadband range using the MME. We construct an optical model, which involves four characteristic parameters including the retardance, the transmission amplitude ratio, the fast axis azimuth and the rotary angle, to descibe the general optical retarder. We further theoretically derive the analytical relations between these characteristic parameters and Mueller matrix elements of the retarder. A broadband MME based on the dual rotating-compensator configuration is set up to perform the experiments. The good agreement between the experimental results and the model-calculated results demonstrates the validity and efficiency of the proposed method.

Keywords: Optical retarder, Characterization, Mueller matrix ellipsometer, Biplate.

D-005

A dynamic calibration method for the pressure transducer

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ABSTRACT

Pressure transducer is widely used in the field of industry. A calibrated pressure transducer can increase the performance of precision instruments in the closed mechanical relationship. Calibration is the key to ensure the pressure transducer with a high precision and dynamic characteristic. Unfortunately, the current calibration method can usually be used in the laboratory with a good condition and only one pressure transducer can be calibrated at each time. Therefore the calibration efficiency is hard to meet the requirement of modern industry with high efficiency. A dynamic and fast calibration technology with a calibration device and a corresponding data processing method is proposed in this paper. Firstly, the pressure transducer to be calibrated is placed in the small cavity chamber. The calibration process only contains a single loop. The outputs of each calibrated transducer are recorded automatically by the control terminal. Secondly, LabView programming is used for the information acquisition and data processing. The performance of the repeatability and nonlinear indicators can be figured out directly. At last the pressure transducers are calibrated simultaneously in the experiment to verify the suggested calibration technology. The experimental result shows this method can be used to calibrate the pressure transducer in the practical engineering measurement.

Keywords: Pressure transducer, dynamic calibration, non-linear, repeatability

D-109

Discussion on the absolute calibration of piezoelectric acoustic emission sensors

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ABSTRACT

The calibration of Acoustic emission sensor is important for acoustic emission quantitative evaluation. To carry out the

sensor calibration, one way is to find a reference acoustic emission source, such as a falling solid ball, a fracturing pencil lead, with energy evaluation to obtain the characteristics of the reference source. One way is to use a reference sensor to measure the pressure or the normal velocity at the surface, including the capacitive transducer and the laser interferometer. The other is using reciprocity method. Frequency characteristics of amplitude of absolute sensitivity of both the Rayleigh and longitudinal waves could be determined by purely electrical measurement without the use of mechanical sound sources of reference transducers. In this paper, the progress of the methods of the AE sensor calibration was given. The principles and the merits and faults of each method are discussed. In this paper the rapid calibration method by pulse exciting transducer was also discussed in different wave mode, as well as Face to Face method.

Keywords: Acoustic Emission Sensor, Calibration, Frequency response

B-044

Multi-sensor Data Fusion Method for Measurement of Complex Freeform Optics

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ABSTRACT

Along with the rapid development of the science and technology in fields like space optics, multi-scale enriched freeform surfaces are becoming widely used to enhance the performance of the optical systems in both functionality and size reduction. Multi-sensor technology is considered as promising method to measure and characterize these surfaces at multiple scales. Therefore, this paper presents a multi-sensor data fusion based measurement method to purposely extract the geometric information of the components from different sensors which will be used to establish holistic geometry of the surface via data fusion. To address the key problems of multi-sensor data fusion, an intrinsic feature pattern based surface registration method is developed to transform the measured data obtained from different sensors to a uniform coordinate frame. Gaussian zero-order regression filter is used to separate each measured data in different scales, and the datasets are fused based on an edge intensity data fusion algorithm within the same wavelength. The fused data at different scale is then merged to form a new surface with holistic multiscale information. Experimental study is presented to verify the effectiveness of the proposed method.

Keywords: Measurement, multi-sensor, freeform surfaces, data fusion, registration

H-038

The impacts of carrier-envelope-offset frequency in dual-comb ranging system

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ABSTRACT

We demonstrate the ranging accuracy of dual-comb time-of-flight ranging system varies sharply and periodically during the carrier-envelope-offset frequency (fceo) tuning. Like the repetition rate difference, fceo should also be treated carefully in this ranging system.

D-165

Research on Stability of nozzle-floating plate institution

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ABSTRACT

In this paper, air hammer instability of nozzle-floating plate institution in gas lubricated force sensor are studied. Establish a theoretical model for the analysis of the nozzle-floating plate institution stability, combined with air hammer stability judgment theorems, Simulation research on the radius of the nozzle, the radius of the pressure chamber, pressure chamber depth, orifice radius and the relationship between air supply pressure and bearing capacity, to explore the instability mechanism of nozzle-floating plate institution. Set up a special experimental device, conducted experimental observations for the stability of two groups nozzle-floating plate institution which have typical structural parameters conducted experimental observations, verify the correctness of the theoretical study and simulation results. This paper shows that the nozzle-floating plate institution, increasing the nozzle diameter, reduced pressure chamber radius, reducing the depth of the pressure chamber and increase the supply orifice radius, such measures is conducive to system stability. Results of this study have important implications for research and design of gas lubricated force sensor.
Keywords: nozzle; gas lubricated sensor; air hammer phenomenon; stability

A-110

Structural Optimization Design on Pneumatic Sensor with Large Measurement Range

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ABSTRACT

Pneumatic measure has been widely used in the high-precision, non-contact measurement, due to its high-precision, self-cleaning, anti-interference, non-contact and the other advantages. Back pressure measurement is used in most cases, but with small measuring range (200μm) and high-precision (0.5μm), limit its scope of application, while reflection-type pneumatic sensor with large measuring rang (4~5mm) and high-precision (5~10μm) can be used for online, non-contact measurement, it may also be applied to the sensor calibration. But structural design of its measuring head has a huge impact on the range and accuracy of the sensor. In this paper, based on hydrodynamics, the finite element model of flow field of the measuring head is systematically constructed, and analyze the influence of sensitivity and linear rang from multiple structural parameters of reflection-type measuring head and flow parameters by using finite element simulation software. Through simulation results under different parameters, we obtained optimal geometrical parameters of reflection-type pneumatic head, so as to achieve the purpose of optimizing the design of reflection-type pneumatic head. From the simulation results, the characteristic curve after optimization has good linearity and large measurement range.
Keywords: Reflection-type pneumatic measurement, Non-contact measurement, Flow field, FEA, Sensor

J-121

Defect depth measurement of Carbon Fiber Reinforced Plastic by thermography

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ABSTRACT

Carbon Fiber Reinforced Plastic (CFRP) has been widely used in all kind of the industries. However the internal defects can result in the change of material properties or mechanical properties, and cause safety problem. Therefore, inspection of the defect area and depth inside the materials in advance is very important for practical usage.
In this study, step-heating thermography is employed to measure the time series temperature distribution of composite plate. The principle of heat conduction in a flat plate with defect inside is introduced. A criterion to determine the depth of defect inside the specimen is derived. Applying this criterion to CFRP specimens of embedded defects, the depth of embedded defect of CFRP can be determined quite well from the time series thermograms obtained experimentally.
Keywords: CFRP, Infrared thermography, step heating, defect depth

A-039

Development of portable and real-time self-calibration angle encoder

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ABSTRACT

At National Institute of Metrology, China (NIM), a portable and real-time self-calibration angle encoder was developed to meet the requirement of angular measurement with high accuracy, high speed, and high adaptability in limited size. In the development, the special arrangement of reading heads, the structure of bearing was designed base on the novel selfcalibration method, and the corresponding signal acquisition and processing system was set up with capability of high speed and multi-channel synchronous data acquisition and processing. The max rotary speed of this angle encoder gets 18 r/min (110°/s) in real-time mode. This angle encoder was compared with NIM's primary angle standard. The calibration result shows that this angle encoder has angle measuring accuracy better than ±4″.
Keywords: Metrology, Angle encoder, Self-calibration, In situ calibration

D-127

Study on self-calibration angle encoder using simulation method

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ABSTRACT

Angle measurement is very important in precision manufacture, optical industry, aerospace, aviation and navigation, etc.Angle encoder using concept 'subdivision of full circle (2π rad=360°)' and transforming the angle into number of electronic pulse is the most common angle measuring instrument. To improve the accuracy of angle encoder, the novel self-calibration method which enables the angle encoder calibrates itself without aid of angle reference was applied. To study the self-calibration method, an angle deviation curve among 0° to 360° was simulated with equal weights Fourier components. The self-calibration algorithm was used the process this deviation curve. The simulation result shows the relationship between the arrangement of multi-reading heads and the Fourier components distribution of angle encoder deviation curve. An actual self-calibration angle encoder was calibrated by polygon angle standard in national institute ofmetrology, China. The experiment result shows the actual self-calibration effect on the Fourier components distribution of angle encoder deviation curve. The comparison between the simulation self-calibration result and the experiment selfcalibration result shows good consistency and prove the reliability of self-calibration angle encoder.
Keywords: Angle measurement, Angle encoder, Self-calibration method, Simulation

I-082

A Novel Double-Ball-Bar with Two Spatial Linkages and One Spherical Joint

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ABSTRACT

As a typical comprehensive error measurement method, the double-ball-bar (DBB) has been invented and used widely for evaluating and diagnosing the accuracy of NC machine tools. But the smaller expansion length of DBB's bar causes a lower detection efficiency, so different length bars have to be used to realize different measurement range. To improve the measuring range of DBB, a new type DBB with two spatial linkages and one spherical joint is present in this paper. Firstly, construction of the new device is introduced. Then, the working principle of new device is analyzed and the mathematical model for detecting machine's precision has been built. With the angle value of spatial linkages and lengths of two bars, circular motions caused by interpolation movement of two shafts can be calculated and compared with theoretical value to evaluate machine tool's accuracy. Finally, the simulation for validating the feasibility of the novel DBB has been done. The results show that the new device, compared with traditional DBB, has reasonable construction. The measuring range could cover most of space and measuring range is continuous.
Keywords: Machine tools, Accuracy detection, DBB, Spherical joint

J-085

Automatic flatness detection system for micro part

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ABSTRACT

An automatic flatness detection system for micro rings is developed. It is made up of machine vision module, ring supporting mod1ule and control system. An industry CCD camera with the resolution of 1628×1236 pixel, a telecentric lens with magnification of two, and light sources are used to collect the vision information. A rotary stage with a polished silicon wafer is used to support the ring. The silicon wafer provides a mirror image and doubles the gap caused

by unevenness of the ring. The control system comprise an industry computer and software written in LabVIEW environment. Get Kernel and Convolute Function are selected to reduce noise and distortion, Laplacian Operator is used to sharp the image, and IMAQ Threshold function is used to separate the target object from the background. Based on this software, the system repeating precision is 2.19 μm, less than one pixel. The designed detection system can easily identify the ring warpage larger than 5 μm, and if the warpage is less than 25 μm, it can be used in ring assembly and satisfied the final positionary and perpendicularity error requirement of the component.
Keywords: automatic detection, ring, flatness, machine vision

F-170

Design and Simulation of a Novel Impact Piezoelectric Linear-Rotary Motor

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ABSTRACT

This paper presents a novel impact piezoelectric linear-rotary motor which is driven by asingle piezoceramictube with two parts of electrodes. From the inner and outer electrodes, longitudinal displacement of the tube is generated and used to actuate the shaft with linear motion ability. From the grooved helical interdigitated electrodes, torsional displacement is generated and used to actuate the shaft with rotary motion ability.Working principle and structural design of the motor are introduced and quasi-static longitudinal and torsional displacements of the tube are estimated. Withestablishedkinematics model of the motor, the working behaviors of the motor are investigated numerically with MATLAB/Simulink software. The stepping characteristics of the linear and rotary motions are analyzed, compared, and discussed. With optimized material selection, structural design, and driving parameters, the proposed linear-rotary motor will provide remarkable performances as a miniaturized multi-degree driving devicefor complex positioning and manipulation applications.
Keywords: piezoelectric tube,linear-rotary, impactmotor, kinematics simulation

F-003

Analysis of automobile engine cylinder pressure and rotation speed from engine body vibration signal

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ABSTRACT

In order to improve the engine vibration signal processing method for the engine cylinder pressure and engine revolution speed, the engine cylinder pressure varying according as the engine working cycle process has been regarded as the main exciting force for engine body forced vibration. Theoretical analysis and experiment results have revealed that the discrete high energy harmonic spectrum lines in engine vibration FFT spectrum have direct relationship with the engine cylinder pressure and the engine rotation speed. That provides a practical and convenient method to design motor revolution rate and cylinder pressure measurement instrument.
Keywords: engine vibration, forced vibration, cylinder pressure, rotation speed

F-153

Blade synchronous vibration measurement based on tip-timing at constant rotating speed without once-per revolution sensor

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ABSTRACT

In this article, a blade synchronous vibration measurement method based on tip-timing at constant rotating speed is presented. This method requires no once-per revolution sensor, which makes it more generally applicable, especially for high pressure compressors of the dual rotor engines. The vibration amplitude and engine order are identified with this method. The theoretical analysis is presented, and the least square method is utilized for vibration parameter identification. The method requires at least four tip-timing sensors if the Campbell diagram is previously known and five sensors if the Campbell diagram is unknown. The method has no strict requirement on the angles among sensors which facilitate the installation of the sensors in the measurement. In some special conditions the method will fail and these conditions are analyzed. Experiments are conducted on a high speed rotor with a fiber based tip-timing system, and the experimental results indicate that the theoretical analysis is correct and the method is feasible.
Keywords: blade tip-timing, synchronous vibration, parameter identification.

F-010

A Circuit Processing Method for Restraining DC Drift for Interferometry of Micro Vibration Measurement

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ABSTRACT

A circuit processing method is present to restrain DC drift after analyzing the traditional signal processing method of interferometry for micro vibration measurement. At first, the circuit diagram is designed and its mathematical model is built, then the theoretical equations of the output signal are derived with the practical parameters. By using SIMULINK simulation, the process for restraining DC drift is present on the conditions of the variations of background intensity. The validity of feedback circuit was verified through analyzing the real experiment data. Theoretical predictions match simulation results, showing that this method effectively restrains DC drift for interferometry of micro vibration measurement and it greatly improves the system's stability.
Keywords: Interferometry; micro vibration; DC drift; feedback.

F-155

Self-powered semi-passive vibration damping system based on self-sensing approach

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ABSTRACT

In recent years, semi-passive vibration damping using Synchronized Switching Damping on Inductor (SSDI) technique has been intensively investigated. In this paper, a self-powered semi-passive vibration damping system based on self-sensing approach is proposed and investigated. With the self-sensing technique, the same piezoelectric element can be used as a sensor and an actuator. Compared with the other self-powered SSDI approaches, this technique can not only detect switching time without lag, but also reduce the number of piezoelectric elements. Furthermore, a low-power circuit for semi-passive piezoelectric vibration control based on self-sensing technique is designed. Experimental results demonstrate that the self-sensing SSDI system has good damping performance. The performance of the self-sensing SSDI system is also compared with the externally powered system.
Keywords: Piezoelectric devices, Vibration control, Semi-passive damping, Self-sensing, Self-powered

F-113

Modal Testing and Vibration Analysis of a 50kW DC Motor Structure

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ABSTRACT

This paper studies model testing and vibration analysis of a 50 kW DC motor structure for electric vehicles. The motor structural components include stator, front cover, rear cover, and disk cover. The stator contains yoke, stator-core and windings. First, solid models of motor components, subassemblies and entire motor assembly are constructed. The solid model of the stator-core is simplified as a hollow cylinder for vibration analysis by the finite element method (FEM). The stiffness effect of silicon teeth and windings are neglected and only the mass effects are considered by adding mass elements to the FEM model. FEM vibration analysis of motor components, subassemblies and entire motor assembly are then carried out to obtain their natural frequencies and mode shapes. The vibration behavior of each components and assemblies are also measured by experimental modal testing. The accuracy of FEM results is compared with modal testing results. To improve the FEM analysis accuracy, it shows that the stator-core, which is made up of laminations of silicon steel, should be considered as orthogonal material, instead of general isotropic material. In addition, stiffness effect and mass effect of each component should be also finely tuned to get more accurate analysis results. For the final FEM analysis model, natural frequencies of the first 5 modes are accurate to about 10%, compared to modal testing results.
Keywords: DC motor, finite element method, modal analysis, modal testing

G-059

Digital Image Correlation based Residual Thermal Strain Measurement Using Laser Hole Drilling

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ABSTRACT

In this work, a Digital Image Correlation technique in combination with the laser hole drilling to measure the residual

thermal strain was presented. The significant potential benefits of this work is non-contact, high speed and on-line measurement. The ring-core based groove in the surface of the specimen was drilled concentrically to induce the thermal stresses presented inside the core. These deformations can be measured by Digital Image Correlation technique for measuring relieved strains. It also investigated the size of the reference areas on the specimens and tracks these areas after the laser hole drilling process. The proposed method was applied to characterize the thermal effect produced by laser milling for aluminum alloy Al5052 under plane strain tension conditions and the results were compared with the four assisted laser milling approach.
Keywords: Hole drilling, residual thermal strain measurement, digital image correlation, ring-core method

B-056

High precision absolute distance measurement with the fiber femtosecond optical frequency comb

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ABSTRACT

The absolute distance measurement was experimentally demonstrated by using the fiber femtosecond optical frequency comb in air. The technique is based on the measurement of cross correlation between reference and measurement optical pulses. This method can achieve accuracy better than the commercial laser interferometer. It is attained sub-micrometer resolution in large scale measurement by using the fiber femtosecond optical frequency comb. It will be benefit for future laser lidar and satellite formation flying mission.
Keywords: distance measurement, femtosecond, frequency comb, cross correlation

E-041

Precise Positioning Method for Multi-process Connecting Based on Binocular Vision

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ABSTRACT

With the rapid development of aviation and aerospace, the demand for metal coating parts such as antenna reflector, eddy-current sensor and signal transmitter, etc. is more and more urgent. However, such parts with varied feature dimensions, complex three-dimensional structures, and high geometric accuracy are generally fabricated using a multi-process manufacturing technology. However, it is significant to ensure the machining precision caused by the accuracy of multi-procedure connection. Therefore, a precise method of tool setting is proposed based on binocular micro stereo vision. First, a novel and efficient camera calibration method for stereoscopic microscope is presented to solve the problems of narrow view field, small depth of focus and too many nonlinear distortions. Then, the extraction algorithms for feature lines and spiral lines are given, and the spatial position relationship between the microscopic vision system and the machining system is determined with high precision. Finally, precise positioning system based on binocular micro stereo vision is set up and embedded into a CNC Machining experiment platform. Experimental results indicate that the average errors of the precise positioning method in the X and Y directions are 2.250μm and 1.777μm,

respectively.
Keywords: multi-process, CNC machining, binocular micro vision, stereoscopic microscope, positioning

G-122

Study on hologram mosaic algorithm based on Harris corners

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ABSTRACT

To solve themeasurement problem of the big object in the process of thehologram reconstruction, the hologram mosaic algorithm based on the Harris corners is proposed. The Harris corners in multi-scale are extractedand the mismatching points are removed. The final homography is calculated by using theimproved RANSAC algorithm based on L-M algorithm. Finally, the stitched hologram with high quality can be obtained based on the weighted average fusion algorithm. It can overcome the influence to the hologram that the incident angles of the object beam are not consistent. Two experiments carried out with different reconstructed distance demonstrate that the proposed algorithm can realize the measurement of the big object by using the hologram method. Furthermore, it has high accuracy and strong robustness.
Keywords: Hologram,image mosaic, Harris corners,homography, RANSAC algorithm, L-M algorithm

G-116

Using Digital Image Correlation for Full-field Measurement of Carbon Fiber Composite under tensile test

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ABSTRACT

This paper presents a method of digital image correlation (DIC) applicable to measure the deformation of carbon fiber composite under tensile test. The proposed technique employs an in-house DIC core for image processing, which makes it possible to obtain displacement and deformation of solids by tracking features on the surface of measured objects, thereby realizing non-contact, full-field measurement. This approach simplifies measurement devices to only a camera (static problems) or a video camera (dynamic problems) for the recording of images. The proposed DIC technique was used to various applications at different scales, including tracking the trajectory of robot arms and the measurement of large displacement for structures (civil engineering) subjected to seismic waves. Our results were compared with those of expensive, high-precision measurement devices, and gave consistent value in different metrology.
In this study, we measured the quasi-static displacement and strain in a cantilever beam and conducted tensile tests on a carbon-fiber composite material using the proposed DIC technique to measure deformation before failure. The results were compared with those obtained using strain gauges. The deformation characteristics of brittle material prior to tensile failure were used to demonstrate the accuracy and reliability of the DIC technique in strain measurement.Unlike ductile materials, which display distinct necking before breaking, carbon fiber composite materials are brittle and break without significant necking when they reach their tensile strength. They show almost no plastic deformation prior to failure, and their tensile strength is limited by defects, such as fiber breakage and interfacial delamination.

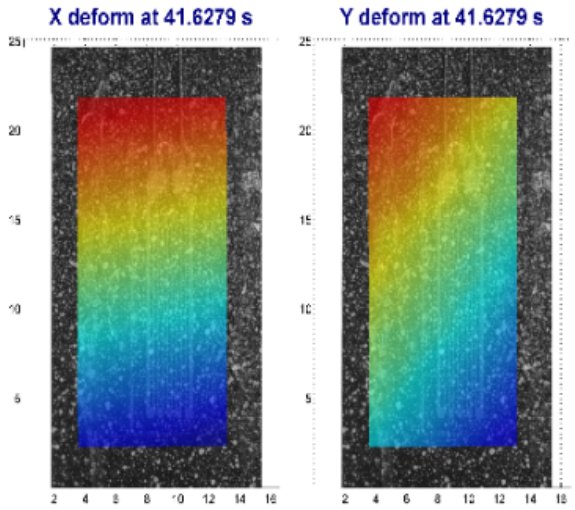

Fig.1 Full-field displacement of carbon fiber composite under tensile test

To increase the tensile strength of carbon fiber composite materials, the number and size of defects must be reduced. In the DIC technique, images of the specimen during the tensile test were captured using a digital camera at a sampling frequency of 86 fps. We then conducted measurements and analysis using the strain gauge. Our DIC technique could reach a resolution of 0.01 pixels, and provide 12.84 μm/pixel in this case. The fixed end of the specimen was gripped with a constant grip force of 125 bar, whereas the other end was pulled at a speed of 2 mm/minute. Fracture failure occurred when the tensile load reached 35 kN. The DIC results show that when the material failed, the tensile strain was approximately 16155 με (or 1.62 %).

The DIC technique developed in this paper makes it possible to obtain non-contact, full-field measurement with high spatial and temporal resolution. It is applicable to numerous problems in various domains and at various scales.

G-164

Research on A Precise Different Box-Counting Method of Eliminating Image Background

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ABSTRACT

The different box-counting (DBC) method has been widely used to calculate fractal dimension, but this algorithm has the limitation to estimate fractal dimension of image with background accurately.In this paper, an improved different box-counting(IDBC) has been proposed to address this issue.Firstly ,the background pixels values G_b of image need to be found out using probability .In the second step, the n_q (n_q is the numbers of boxes in a grid) was set to zero when the maximum and minimum in a grid were equal to image background values.The fractal dimension of different sizes' black background images and original texture images were estimated and compared through different algorithms, including DBC, relevant different box-counting method (RDBC), shifting different box-counting method(SDBC) and improved DBC(IDBC)method. The experimental results demonstrate that the IDBC developed in this work has the ability to improve the measurement accuracy by avoiding the influence caused by background.

Keywords: different box-counting method;fractal dimension;improved different box-counting method

J-114

High-resolution optical inspection system for fast detection and classification of surface defects

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ABSTRACT

This paperdevelopsahigh-resolution automated optical inspection (AOI) system based onparallel computing to carry out fastinspectionandclassification of surface defects. The AOI equipmentusesa 12288-pixel linearCCD camera with apixel resolution of 3.5 mand operates at10kHz linearspeed. The specimen mounting is on alinear translation stagewithillumination source fromanLED array. In order to carry out fast inspection, the AOI apparatus is linkedto a central computer, which executes image processinginstructions in a graphical processing unit (GPU) using Compute Unified Device Architecture (CUDA) and Message Passing Interface (MPI) programming models. Theinspection results are displayed as defect maps on a user interface window. Fastdefect classification isimplemented by a back propagation neural (BPN) approach. The classification training formulticlass defectsusing this method is fast and accurate. The experimental results on the optical inspection of touch panel glassshow that, using a small number of training samples and few iteration cycles,the detection and classification of defects can be implementedfast. The inspection alone ofa43 mm(W) x 229 mm(L)sample even if it yields 800 megapixel data can be completed in lessthan3 s.By using at least 40training samples and 500 cycle iterationsin the BPN,the classification ofbubble-like defectsand micro-scratchescan be completed in less than 1 millisecond.Thus, the developedsystem can be used to carry out fast, reliableand fully-integratedinspectionand classification equipment for in-line measurements.
Keywords: Surface Defect Inspection, Touch Panel Glass, Message Passing Interface, Parallel Computing, Back Propagation Neural

A-011

Modeling and analysis of magnetic field distribution of Square Pane Permanent Magnet in IntelligentBall Hinge

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ABSTRACT

The reasonable distribution of the permanent magnetic fieldhas important influence on improving the measuring accuracy and resolution of intelligent ball hinge.In view of the defects and deficiencies of the ring permanent magnet in the previous experiment scheme, a new method with Square Pane Permanent Magnet(SPPM) is put forward, which possess distinct advantages onorientation identification and model simplification.This paper proposes an optimized square pane theory model of the distribution of SPPM field andestablishes theoretical expressions of the magnetic field. The comparison experimentwas designed and carried out. It can be found that the experimental data basically agreed with the theory value with less than 4.3% error in full scale, the results verified the correctness and rationality of the analytic work. It provides a new theoreticalsupportfor the follow-up study and also paves the way for improving the measurement accuracy and resolution of intelligent hinge.
Key words: intelligent ball hinge; square pane PM; magnetic induction intensity; distribution of PMfield

E-106

CFD simulation and optimization of the capillary throttling of air-flotationunit

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ABSTRACT

With respect to the torus throttling, capillary throttling have following advantages: smaller mass flow rate and stronger anti-interference ability. For the new restriction mode, this paper firstly gives the required average pressure of air-film when shipping a piece of LCD glass. Then, the dimensional flow model of the capillary throttling of air-flotation transport unit is established. Based on the model, firstly analyze the flowing process of the lubricated air through the capillary and give the mass flow rate as a result. Secondly, the pressure distribution equation of air-film is derived from Navier-Stokes Equation. Furthermore, the functional relations between the model parameters and static characteristics of the air-film, such as mass flow rate, static bearing capacity and so, are obtained and then analyze the influence of the former on the latter. Finally, according to the continuity of airflow, the function relation between model parameters and pressure of core nodes in the air-film is also derived.
On the foundation of theoretical analysis, the impact of each model parameter on the static characteristics of the air-film flow field, is respectively simulated and analyzed by CFD software Fluent . Based on these simulations and analysis, radius and length of the capillary, density of the gas supply orifices, supply pressure and other model parameters are optimized. Finally, the best unit model is acquired, which greatly improve the static working performance of the air-film in air-flotation unit. Research results of this paper can provide basis for the design and optimization of air-flotation transport system.

Keywords: capillary throttling,air-film flow field, Finite volume method, air-flotation transport system

F-119

Measurements of Interfacial Heat Flux for Accurate Numerical Simulations of A Liquid Impinging Thermoelectric Cooler (LITEC)

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ABSTRACT

In the past, various liquid-impinging coolers have been designed for electronics cooling because of the high heat transfer performance at the interface between the flow domain and the heated part. A curved chamber was designed to form the centrally impinging liquid jet for the purpose of cooling without the formations of vortices, which were shown ineffective for cooling. A thermoelectric cooler was later combined with the liquid impinging cooler to enhance the controllability of the entire cooling system. The tradeoff between the cooling performance and the energy awareness was investigated. Experimental results showed the liquid impinging thermoelectric cooler (LITEC) is capable of removing proper amount of heat from the source under allowable energy consumption. To further enhance the current design, it is desirable to rely on numerical simulations. However, the heat transfer at the interface between the impinging flow and the heated part of the heat sink is often randomly distributed. There will be large errors in the numerical simulations without proper measurements of the interfacial heat flux as the boundary condition. In this paper, an experimental set-up was designed to measure the interfacial heat flux. The experimental results confirmed the heat flux distribution is not uniform. The nonlinear heat flux distribution was parametrically modeled using Kriging method and considered as the boundary condition in the numerical simulations. Our implementations showed the numerical simulations have better agreements with the experimental results when nonlinear boundary conditions were used.
Keywords: liquid impinging thermoelectric cooler (LITEC), numerical simulations, interfacial heat flux, accurate boundary conditions, Kriging.

I-154

Study on evaluation methods of the gear pitch deviations based on statistical analysis

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ABSTRACT

It is a key problem that how to measure and evaluate the pitch deviations of automotive gears rapidly. Two measures are taken to solve this question. First, a specific rapid inspection machine for automotive gears based on the gear integrated error (GIE) technology has been developed. The efficiency of the rapid inspection machine is fairly high. The rotational speed of the master worm is up to 200 rpm. Under this condition, a profile of a tooth flank can be measured in 0.3 second. The machine can get analytical results including pitch deviations rapidly. Second, a new approach of gear evaluation and a set of new parameters of the pitch deviations are proposed in this paper. The values of the new parameters are more stable than those of the traditional parameters and relatively not sensitive to random errors of the measurements. The principles of the new evaluation system of gear accuracy based on statistical analysis are described and the definitions of the new parameters of pitch deviations are proposed. Then the rapid inspection machine of automotive gears based on GIE technology are introduced as an ideal instruments that can acquire pitch deviations much more quickly than others. For the verification of both the effect of the new parameters of pitch deviations based on statistical analysis and the efficiency of the rapid inspection based on GIE, a serial of measuring experiments are performed in different conditions. The comparison of the results shows that the new parameters are suitable to evaluate the pitch deviations of gears under the condition of high efficient measuring.
Keywords: gear accuracy, pitch deviation, evaluation system, statistical analysis

G-112

Expanding quantitative phase measurement of differential interference contrast system using water-immersion technique

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ABSTRACT

We proposed a water immersion PS-DIC system to improve the measuring ability and expand the measureable range of object shape. For the objects surrounded by water, the deflection of light become smaller so that more light can be detected. In addition, the optical path differences decrease avoiding the phase wrapping problem because of the reducing difference of refraction index between the object and it surrounding. Series of simulations for various inclined angles of prism from 10° to 45° were simulated. Experiments are also conducted to verify the water immersion technique and demonstrated the ability of the proposed system. This study provides a useful information for measuring complex geometries of object with PS-DIC technique and shows the possibilities for apply water immersion technique to expand the measureable range of object shape.
Keywords: Interferometric imaging; Surface measurements, figure; Industrial optical metrology

I-103

Measurement system and precision analysis for bending and twisting properties

evaluation of textile fabrics

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ABSTRACT

A new test method and a measurement system was proposed and developed to evaluate the bending and twisting properties of textile fabrics. The measurement system and the test method is based on the mechanical device, sensors and microelectronics and simulates the dynamic process during the fabric is bent and twisted. The virtual instrument based system can measure the dynamic changes of the signals due to the bending and twisting loads. Derived from the test data, a series of indices are defined to characterize the bending and twisting properties. The test and evaluation method, the experiments and the test results are reported. The analysis of the variance for intra-laboratory test was performed to determine the precisions of the test method and the measurement system. The measurement system provides a method for objective measurement and evaluation of bending and twisting properties of textile fabrics.
Keywords: Bending, Twisting, Measurement, Precision, Textile fabrics

I-104

Precision evaluation of calibration factor of a superconducting gravimeter using an absolute gravimeter

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ABSTRACT

The precision of the calibration factor of a superconducting gravimeter (SG) using an absolute gravimeter (AG) is analyzed based on linear least square fitting and error propagation theory and factors affecting the accuracy are discussed. It can improve the accuracy to choose the observation period of solid tide as a significant change or increase the calibration time. Simulation is carried out based on synthetic gravity tides calculated with T-soft at observed site from Aug. 14th to Sept. 2nd in 2014. The result indicates that the highest precision using half a day's observation data is below 0.28% and the precision exponentially increases with the increase of peak-to-peak gravity change. The comparison of results obtained from the same observation time indicated that using properly selected observation data has more beneficial on the improvement of precision. Finally, the calibration experiment of the SG iGrav-012 is introduced and the calibration factor is determined for the first time using AG FG5X-249. With 2.5 days' data properly selected from solid tide period with large tidal amplitude, the determined calibration factor of iGrav-012 is (-92.54423±0.13616) μGal/V (1μGal=10-8m/s2), with the relative accuracy of about 0.15%.
Keywords: calibration factor; superconducting gravimeter; absolute gravimeter; precision evaluation

I-161

Measurement and Characterization of Three Dimensional (3D) Microstructures on Precision Roller Surfaces

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ABSTRACT

Precision roller with microstructures is the key tooling component in the precision embossing by roller process such as Roll-to-Roll to manufacture optical plastic plates or films with three dimensional (3D)-microstructures. Measurement and analysis of 3D-microstructures on a precision roller is essential before the embossing process is being undertaken to ensure the quality of the embossed surfaces. Different from 3D-microstructures on a planar surface, it is difficult to measure and characterize the 3D-microstructures on the cylindrical surface of a precision roller due to the geometrical complexity of such integrated surfaces such as V-groove microstructures on a cylindrical surface. This paper presents a study of method and algorithms for the measurement and characterization of 3D-microstructures on a precision roller surface. A feature-based characterization method (FBCM) is proposed to analyze the V-groove microstructures. In this method, a normal template is generated based on the design specifications, and the measured data is fitted with the feature points. Hence alignment and matching of the measured data to the normal template based on the derived feature points are undertaken. After that the V-groove is characterized by some feature parameters such as pitch, depth, angle of the V-grooves. The method also provides an approach for the analysis of burs generated during the machining of V-groove microstructures. A precision roller with V-groove microstructures has been machined by a Four-axis ultra-precision machine and the machined surface is measured by a contact measuring instrument. The measured data are then characterized and analyzed by the proposed FBCM. The results are presented and discussed, and they indicate the dominant and regular machining errors that are involved in the machining of the V-groove microstructures on roller surfaces.
Keywords: Precision roller, microstructure, surface measurement, feature parameter, data analysis, data fitting, machining error, ultra-precision machining

I-002

Uncertainty estimation in form error evaluation of freeform surfaces for precision metrology

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ABSTRACT

Freeform surfaces are widely applied in precision components to realize novel functionalities. In order to obtain the correct form errors of the manufactured parts, matching/fitting is required. The uncertainty of the form error parameters needs to be estimated so as to assess the reliability of the evaluating process. The conventional GUM approach is not suited for such complex nonlinear models. In this paper we develop a Monte-Carlo method to assess the uncertainty of form error evaluation of freeform surfaces. The stability of the fitted position, shape and form error parameters is assessed. Based on correlation analysis, the effects of some major factors, including objective functions, noise amplitudes, shapes etc can be determined, and the significant factors influencing the evaluated form errors can be specified. By appropriate planning of the measuring and matching procedure, the uncertainty of the evaluation results can be reduced, and thereby improving the reliability of freeform surface characterization.
Keywords: Precision metrology, freeform surface, uncertainty, Monte-Carlo method

A-018

Development of a three-dimensional angle errors detection and

compensation system for two-dimensional stage

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ABSTRACT

In order to compensate three-dimensional (3D) angle errors of two-dimensional (2D) stage in motion, a 3D angle errors detection and compensation system using a modified DVD pick-up head has been developed in this paper. The modified DVD pick-up head, which consists of a commercial DVD pick-up head without objective lens and voice coil motor, is used as an angle sensor. The mechanism of the angle sensor is based on optical auto-collimation, and each sensor can detect two deflection angles of the stage simultaneously. Utilizing the angle error information obtained by two angle sensors which are set along X and Y moving direction respectively, the controlling system adjusts the nano-positioning stage by controlling the piezoelectric ceramic actuators' movement to compensate the angle errors of the stage. This system can achieve the measurement and compensation of yaw angle error, pitch angle error and roll angle error of the stage. Experimental results show that the angle detection range of this system is ±110″, the resolution is about 0.2″, and the repeatability error is about 2″. After compensating, the 3D angle errors of 2D stage can be controlled within 3″. This system has the advantages of compact structure, low cost, etc.
Keywords: DVD pick-up head, optical auto-collimation, two-dimensional stage, angle errors compensation

I-015

The Slider Motion Error Analysis by Positive Solution Method in Parallel Mechanism

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ABSTRACT

Motion error of slider plays key role in 3-PUU parallel coordinates measuring machine (CMM) performance and accuracy, so an in-depth study is need to pursue. The research and work starts in a new view and method. First, the structurerelation of slider and guide can be abstracted as a 4-bar parallel mechanism. So, the sliders can be considered as moving platform in parallel mechanism. Its motion error analysis is also transferred to moving platform position analysis in parallel mechanism. Then, after establishing the positive and negative solutions, some existed theory and technology for parallel mechanism can be applied to analyze slider straightness motion error and angular motion error simultaneously. Thirdly, some experiment by autocollimator was carried out to capture the original error data about guider its own error, the data can be described as straightness error function by fitting curvilinear equation. Finally, the Straightness error of two guides were considered as the variation of rod length in parallel mechanism, the slider's straightness error and angular error can be obtained by putting data into the established model. The calculated result was generally consistent with experiment result. The idea will be beneficial on accuracy calibration and error correction of 3-PUU CMM and also provides a new thought to analyze kinematic error of guider in precision machine tool and precision instrument.
Keywords: motion straightness error, angular motion error, parallel mechanism,CMM

I-014

Measurement uncertainty evaluation in multi-strategies of CMM

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ABSTRACT

The estimated value of the measured parameters is the only value obtained in the present application of coordinate measuring machine (CMM), and uncertainty evaluation of measured parameters must be done in order to obtain a complete measurement results. Error sources causing the uncertainty of the measured parameters of CMM are very complex, and uncertainty evaluation technician is also required to have certain expertise and experience of assessment. Therefore, uncertainty evaluation has always being one difficult issue in application of CMM. Based on geometrical product specifications (GPS), the three measurement strategies of CMM application were researched, which included conventional measurement, substitution measurement and compensation measurement strategies. For each measurement strategy, the uncertainty sources were analyzed, and the corresponding task-oriented uncertainty evaluation model was established. At last, the hole diameter measurement of one part was taken as an example. It was evaluated respectively by the three different strategies, and the results were compared. Judging from the comparison results, the influence on measurement results was very different for the three measurement strategies, and the maximum difference between the measurement uncertainty results was more than 2 times. Both the analysis procedure and result comparison show that it is important to take proper measurement strategy for specific measurement task, which can improve accuracy of measurement in practical application.
Keywords: Coordinate measuring machine (CMM), Measurement uncertainty, Measurement strategy, GPS, ISO 15530

D-068

Influences of pulse on the performance of phase-sensitivity OTDR

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ABSTRACT

The influences of pulse, including the pulse width Tp and the peak pulse power Ipeak, on phase-sensitivity optical time domain reflectometer (φ-OTDR) based distributed vibration sensor are investigated in this paper. A numerical simulation is performed to illustrate the relationships between pulse and fluctuations ratio coefficient (FRC) as well as visibility of interferential Rayleigh backscattering light. The simulation results show that the method of amplifying Ipeak is benefit for increasing the FRC induced by vibration, while it is useless for improving the visibility. In contrast, the method of broadening Tp is useful for increasing the FRC by improving the visibility. Laboratory experiments are implemented by using the φ-OTDR prototype with an electro-dynamic vibration table producing stable vibration signals. The good agreement of experimental with simulated results validates the theoretical analysis.
Keywords: Distributed sensor; vibration sensor; fiber optics sensors; optical time domain reflectometer (OTDR).

B-022

A measurement system for surface topography based on three-wavelength interferometry

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ABSTRACT

Optical microscopic interferometry is an important measurement method for surface topography. There is usually contradiction between enlargement of measuring interval and improvement of measuring precision. In this paper, a three-wavelength interference measurement system for surface topography based on wavelength switch and phase shift scanning is proposed. A data processing method for three-wavelength interference images is proposed, which use the phase extraction and recognition algorithm based on elliptic fitting and combined size scales of phase difference. The method can effectively improve the overall precision of surface topography measurement and expand measuring interval to nearly 27 times that of single wavelength 640 nm. Experimental results have shown that the relative measurement error of surface roughness of square wave specimen with multiple grooves is only 4.1% compared to the data calibrated by China National Institute of Metrology. Therefore, the three-wavelength interferometry method can realize high precision measurement for surface topography in a certain range.
Keywords: Measurement for surface topography; phase shift interference; three-wavelength interferometry; initial phase; phase difference; equivalent wavelength; interferogram

G-071

Sub-Pixel Edge Detection of High Temperature Environment Image Using Dual Fitting Algorithm

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ABSTRACT

This literature describes a method of non-contact distance measurement in high-temperature environments by video extensometer. In order to detect the distance of a pair of marked lines on the specimen, dual fitting algorithms are proposed. The first fitting method which is least squares curve fitting utilizes hyperbolic tangent function to fit a set of discrete gray level points as a curve. So the set of edge points of two lines were located. The second is to use orthogonal linear least squares method to fit the set of edge points derived from first fitting result as two lines respectively. So the distance of two lines are obtained. A video extensometer system which enables a high temperature distance measurement up to 1200℃ is presented and demonstrated by experimental measurements.
Keywords: High temperature image, Sub-Pixel edge detection, Curve fitting algorithm

J-029

Design of automatic optical inspection (AOI) system for flat plate surface defects

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ABSTRACT

The paper first introduces the components of the automatic optical inspection (AOI) system for flat plate surface defects：Camera, light source, data acquisition card, PLC controller, adjusting bracket and Human Machine Interface HMI) etc.; Then using LCD panel as an example, analysis of the time domain characteristics of one-dimensional (1D)line images of the surface defects. By utilizing 1D Fourier transform to convert 1D line images into the frequencydomain, set the periodic peaks to zero and back-transformed to the time domain image using the 1D inverse Fourier transform to eliminate the periodic background. The defective segments can be easily separated from the uniform background with simple statistical control limits. The experiment analysis for the test result under different

defects which involves fiber, stains and scratches respectively shows that the system can accurately detect the defective region of LCD panel surface.
Keywords: automatic optical inspection; surface defects; one-dimensional Fourier transform; line images

G-097

Design and Experiment on a Multi-functioned and Programmable Piezoelectric Ceramic Power Supply with High Precision for Speckle Interferometry

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ABSTRACT

Speckle interferometry is a method of measuringstructure'stiny deformationswhich requires accurate phase information of interference fringes. The phase information is acquired by micro-displacement produced bypiezoelectric ceramic (PZT). In order to drive the PZTmicro-displacement actuator, a multi-functionedand programmable PZT power supply with high precision is designed. Calibration experiment is done to thePZT micro-actuator in speckle interferometry. Some experiments are also done to test its relevantcharacteristics. The experiment results show that it has high linearity, repeatability, stability, low ripple and can meet the requirement of the reliability and displacement accuracy in speckle interferometry.
Keywords: speckle interferometry; phase shift; piezoelectric ceramic; power source;

A-107

Mutation particle swarm optimization of the BP-PID controller for piezoelectric ceramics

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ABSTRACT

The piezoelectric ceramic driving system used in the grating nano measure system is studied. Because of some shortcomings of the traditional PID controller, such as excessive overshoot amount of the control result, the parameters setting are difficult to achieve the optimal state and long adjustment the time, etc, thus, it is difficult to meet the requirements of the piezoelectric ceramic driving system. In order to effectively control the piezoelectric ceramic driving system and improve the positioning accuracy, this study uses the mutation particle swarm optimization algorithm(MPSO) to the process of the parameter setting of BP-PID, and design a high efficiency and stable adaptive controller, which is the BP neural network controller based on mutation particle swarm optimization(MPSO-BP-PID). In the variation mechanism of the MPSO, with adopting the group fitness variance and the group optimal fitness value as the standard, carrying out the mutation operation, which can overcome the precocious and continue to be optimized, to improve the convergence precision and further strengthen its global search ability, which will make the MPSO-BP-PID accomplish the control of the controlled objects with the faster speed, higher accuracy. Therefore, the MPSO-BP-PID is applied to the piezoelectric ceramic driving system, which overcomes effectively the hysteresis, nonlinearity of the piezoelectric ceramic driving system. In the simulation experiment, compared with BP-PID and PSO-BP-PID, MPSO-BP-PID improves significantly the system dynamic performance and steady-state precision of the system, meanwhile, the system has stronger adaptability and robustness.

Keywords: piezoceramic, proportional integral derivative(PID), mutation PSO algorithm, neural network, MATLAB

A-061

Wheel pose measurement based on cross structure light

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ABSTRACT

It's necessary for automobile to detect and adjust four-wheel alignment parameters regularly due to the significant effect on improving stability, enhancing security and reducing tyre wear of automobile. In order to measure the parameters determined by position and posture of four-wheel relative to automobile cab, a method applying monocular vision of linear structure light to wheel pose measurement, is proposed in this paper, space coordinates of feature point cloud are calculated out from the principle of structured light firstly, after that, a algorithm is designed to determine the normal vector of wheel tangent plane, thus measuring the wheel pose, actual experiments are carried out finally to verify the system accuracy by evaluation of adjusted wheel angle measurement. The corresponding studies in this paper lay the foundation for designing and developing 3D four-wheel alignment system based on structured light.
Keywords: Structure light measurement; wheel tangent plane; rotated angle; vision measurement

A-102

Posture Metrology for Aerospace Camera in the Assembly of Spacecraft

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ABSTRACT

During the spacecraft assembly process, the posture of the aerospace camera to the spacecraft coordinate system needs to be measured precisely, because the posture data are very important for the earth observing. In order to measure the angles between the camera optical axis and the spacecraft coordinate system's three axes x, y, z, a measurement scheme was designed. The scheme was based on the principle of space intersection measurement with theodolites. Three thodolites were used to respectively collimate the camera axis and two faces of a base cube. Then, through aiming at each other, a measurement network was built. At last, the posture of the camera was measured. Through error analysis and measurement experiments, the precision can reach 6″. This method has been used in the assembly of satellite GF-2 and good results were obtained.
Keywords: aerospace camera; satellite assembly: optical alignment; theodolite

B-054

B-095

Real-time Precision Measuring Device of Tree Diameter Growth

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ABSTRACT

DBH(diameter at breast height) is an important factor to reflect of the quality of plant growth, also an important parameter indispensable in forest resources inventory and forest carbon sink, the accurate measurement of DBH or not is directly related to the research of forest resources inventory and forest carbon sink. In this paper, the principle and the mathematical model of DBH measurement device were introduced, the fixture measuring device and the hardware circuit for this tree diameter were designed, the measurement software programs were compiled, and the precision measuring device of tree diameter growth was developed. Some experiments with Australia fir were conducted. Based on experiment data, the correlations among the DBH variation of Australian fir, the environment temperature, air humility and PAR(photosynthetically active radiation) were obtained. The effects of environmental parameters (environment temperature, air humility and PAR) on tree diameter were analyzed. Experimental results show that there is a positive correlation between DBH variation of Australian fir and environment temperature, a negative correlation between DBH variation of Australian fir and air humility , so is PAR.
Keywords: tree diameter growth; precision measuring; correlation; environmental parameters

C-013

Characterization of Non-conductive Materials Using Field Emission Scanning Electron Microscopy

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ABSTRACT

With the development of science and technology, field emission scanning electron microscope (FESEM) with its advantages of high magnification, high resolution and easy operation plays an important role in nano-material measurements. A high-quality secondary electron image is a significant prerequisite for accurate and precise length measurements. In order to obtain high-quality secondary electron images, the conventional treatment method for non-conductive materials is to coat conductive films with gold, carbon or platinum to reduce charging, but this method will cover real micro structures of materials, change the sample composition properties and meanwhile introduce a relatively big error to nano-scale microstructure measurements. This paper discusses how to reduce or eliminate the impact of charging effect on image quality to the greatest extent by changing working conditions, such as voltage, stage bias, scanning mode and so on without the treatment of coating, to obtain real and high-quality microstructure information of materials.

C-024

The Processing Technology of PMMA Micro-fluidic Chip

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ABSTRACT

To rich the method of making micro-fluidic chip and simplify the processing technology of micro-fluidic chip，the paper discussed the production process of micro-fluidic chip with PMMA(polymethyl met hacrylate) as cover plate and bottom plate and double-sided adhesive layed as channel layer. The design and machining process of the chip were detailed, and one droplet separation micro-fluidic chip was taken as an example which the dimension is 40 mm(long)×20 mm(width)×2.2 mm(thick) in the paper. Experimental results proved that the chip's high surface quality was compact enough to fast processing speed, mass production of micro-fluidic chip could be achieved by using this technology to processing chip.
Keywords: micro-fluidic chip; PMMA ; laser processing

D-028

Signal Interpolation System for Linear Time Grating Displacement Sensors

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ABSTRACT

As regards the problems of using absolute linear time grating sensors as the position detector for full closed-loop CNC system, it is necessary transform temporal information to spatial information with time-space transformation algorithm for absolute linear time grating sensors. Time grating sensor' signal interpolation model is established with time series. The purpose is to extract the relation mapping between future measurement value and past measurement value. In this way, original absolute displacement signal sampled in equal time interval can be converted to continuous incremental pulses required by full closed-loop CNC system. Furthermore, the predicted error model is proposed to improve the interpolation accuracy. The experiment results prove that the interpolation accuracy can reach 0.65 μm, the resolution can reach 0.1 μm.
Keywords: Signal interpolation, predicted error model, time series, interpolation accuracy, linear time grating

D-064

Design of strain tension sensor of steel wire rope used in the coal mine

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ABSTRACT

According to the dynamic tension testing requirements of the multi-rope winder rope, this paper designs the sensor used to measure the tension of steel wire rope directly. The sensor uses the strain shear measuring principle, and has many features with small size, big measuring range, easy to install, don't change the structure of connected devices and so on.

Application of the finite element analysis software makes the structure of the sensor optimized, and then enhance the static and dynamic performance of the sensor.
Keywords: strain; steel wire; tensity;sensor; finite element

D-053

Analysis and simulation method of the cantilever FBG sensors

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ABSTRACT

To enrich the sensing mechanism of the FBG sensors, the cantilever FBG sensor is taken as an example to analyze the effect of the deflection on the embedded stress distribution and structure parameters of the FBG, and a widely applicable analysis method is thus proposed. Models of the single-core and multi-core FBG sensor are built by the proposed method and a modified transmission matrix method is utilized to simulate built models. The lateral resolution of the multi-core FBG sensor is proved to be 1500 times higher than the single-core FBG sensor. Simulation results of the proposed models indicate that this approach is tally with the experiment of other researches, and it can be used to analyze the performance of the designed sensors, such as spectrum signal and resolution, or as a guide of designing FBG sensors.

D-067

High-resolution Diffraction Grating Interferometric Transducer of Linear Displacements

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ABSTRACT

A high-resolution transducer of linear displacements is presented. The system is based on semiconductor laser illumination and a diffraction grating applied as a length master. The theory of the optical method is formulated using Doppler description. The relationship model between the interference strips, measurement errors and the grating deflection around the X, Y and Z axes and translation along the Z axis is built. The grating interference strips' direction and space is not changed with movement along the X (direction of grating movement), Y (direction of grating line), Z axis, and the direction and space has a great effect when rotating around the X axis. The space is little affected for deflection around the Z axis, but the direction is changed dramatically. In addition, the strips' position shifted rightward or downwards respectively for deflection around the X or Y axis. Because the emitted beams are separated on the grating plane, the tilt around the X axis error of the stage during motion will cause the optical path difference of the two beams resulting in phase shift. This study investigates the influence of the tilt around the X axis error. Experiments show that after yaw error compensation, the high-resolution diffraction grating interferometric transducer readings can be significantly improved. The error can be reduced to ±30 nm maximum from ±80 nm.
Keywords: displacement measurement, diffraction grating, interferometers, interference strips

D-069

Three-dimensional particle focusing under viscoelastic flow based on dean-flow-coupled elasto-inertial effects

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ABSTRACT

Based on dean-flow-coupled elasto-inertial effects, 3D particle focusing in a straight channel with asymmetrical expansion–contraction cavity arrays (ECCA channel) is achieved. First, the mechanism of particle focusing in both Newtonian and non-Newtonian fluids was introduced. Then particle focusing was demonstrated experimentally in this channel with Newtonian and non-Newtonian fluids using three different sized particles (3.2μm, 4.8 μm, 13 μm), respectively. The influences of flow rates on focusing performance in ECCA channel were studied. Results show that in ECCA channel particles are focused on the cavity side in Newtonian fluid due to the synthesis effects of inertial and dean-drag force, whereas on the opposite cavity side in non-Newtonian fluid due to the addition of viscoelastic force. Compared with the focusing performance in Newtonian fluid, the particles are more easily and better focused in non-Newtonian fluid. A further advantage is three-dimensional (3D) particle focusing in non-Newtonian fluid is realized according to the lateral side view of the channel while only two-dimensional (2D) particle focusing can be achieved in Newtonian fluid. Conclusively, this Dean-flow-coupled elasto-inertial microfluidic device could offer a continuous, sheathless, and high throughput (>10000 s-1) 3D focusing performance, which may be valuable in various applications from high speed flow cytometry to cell counting, sorting, and analysis.
Keywords: Microfluidic, Dean-flow-coupled elasto-inertial effects, 3D particle focusing

D-073

Design of the Micro Pressure multi-node Detection System for Micro-fluidic chip

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ABSTRACT

The paper designed a online multi-node microfludic pressure data measuring system in which the flow pressure’s range is under 2Kpa. The test circuit system and graphical user interface were carefully designed.The micro-pressure sensor of MPXV7002 based on MEMS technology was selected to measure the fluidic inside channel of one kind of PMMA micro-fluidic chip, which were installed by the silicone tube connecting with the different micro-channel measured nodes.To deal with the large multi-node pressure datas, the filtering and smoothing method were used in the paper, and the estimation and correction to pressure transmission loss had been carried on too. Finally,we also carried out the multi-node pressure test experiment, analysesed the experimental data and calibrated the system. The experimental results show that the system has the high testing precision.
Keywords: Micro-fluidic Chip;micro-pressure; MPXV7002 ;

D-080

All-Fiber Biosensor Employing Propidium Iodide for Rapid Detection of Dead Escherichia Coli O157:H7

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ABSTRACT

A low-cost and compact optical fiber biosensor employing propidium iodide (PI) as the dead bacterial strain is used to specially detection of dead bacteria. Combination tapered optical fibers produced by a simple tube-etching and activated by a covalent modification serve as the fiber probe for detection. The total process could be finished within 30 min. The detection limit of dead Escherichia coli (E. coli) O157:H7 is 104 cfu mL-1 without interference of live E. coli O157:H7 and other six E. coli serotypes at even 107 cfu mL-1. By coupling with other fluorescence dye and specific antibody, this method can also be used to differentiate the dead or live cell of other kinds of bacteria. The method with high sensitivity and specificity could support a good platform for differentiation of dead and live bacteria in microbiological detection.
Keywords: all-fiber biosensor, dead bacteria, propidium iodide

D-094

An active ultra-low frequency vertical vibration isolator

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ABSTRACT

An active ultra-low frequency vertical vibration isolator is presented in this paper, which could isolate the vibration from the earth. It could create an inertial reference point for some precision physics research and experiments such as high precision absolute gravity measurement. This system is based on a structure with two-stage vertical suspension springs. For the second-stage spring, the suspension point is forced to track the suspended mass through closed loop control, and the length of the spring is almost constant and the restoring force of the mass is closed to zero. Consequently, a system with an ultra-low frequency is realized. With precision mechanical design, high resolution photoelectric detection method, and analog circuit feedback control, a vertical vibration isolation system has been constructed with a period of up to about 40s. This vibration isolator meets the demand of high precision absolute gravity measurement and is promisingly applied to the homemade T-1 absolute gravimeter.
Keywords: vertical vibration isolator; ultra-low frequency; active control; absolute gravimeter

D-126

Research on The Three-Dimensional Force Sensor Based on

The Giant Magnetostrictive Material

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ABSTRACT

Giant magnetostrictive material (GMM) is an attractive material for sensors due to its characteristics of high relative permeability and high magneto-mechanical coupling coefficient. Based on the villari effect and crystal anisotropy theory of this materials, the mathematical models which describe the relation between GMM rod permeability and its pressure, the relation between induction coil inductance and its relative permeability were built in this paper. The built models were simulated and analyzed by using MATLAB. The results show that there exists a good linear relationship between the pressure exerted on the GMM rod and the inductance of induction coil, which provides a theoretical basis to design a three-dimensional force sensor with high precision, high stability and good output characteristics.
Keywords: GMM , villari effect , force sensor, inductance

E-016

Simulation and communication analysis of hydraulic support pressure monitoring system based on CAN bus

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ABSTRACT

In order to realize online real-time monitoring of the hydraulic bracket support, improve the existing communication system, improve the reliability of data transmission, this paper set up the communication system simulation and communication platform to simulate the coal mine communication based CAN bus. Based on the design and analysis of system hardware and software, this paper completed the construction of the whole hardware and communication system debugging. The debug end can communication simulation by the CAN protocol simulation device, and realized the work of the entire communication. Experiments show that the monitoring system can work reliably.
Keywords: hydraulic support; CAN bus; monitoring system

E-026

Research on Algorithm of Blade vibration for General wind turbine

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ABSTRACT

Evaluation of vibration characteristics for wind turbine blades is one of the important contents in the wind turbine research. This paper uses the compressible flow equations with the preconditioning technique, based on the finite volume method and combined with the LU-SGS algorithm for solving the flow area; meanwhile adopts the two degree of freedom of vibration equation with the vertical and torsional vibration for blades to simulate the vibration trajectory of blade under the aerodynamic force, uses the motion grid algorithm for changes in grid computing domain. Calculation program was developed autonomous in the C ++ platform, and the development of software correctness was verified by contrast the results of the classic cylindrical examples. Finally, the vibration characteristics of a wind turbine blade was given, and the software developed in this paper can provide technical support for wind turbine blade vibration study.
Keywords: blade vibration; fluid-structure coupling; CFD; wind turbine

E-027

Design of Three Degrees of Freedom Hybrid Vibrating Screen Dynamics and Control System

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ABSTRACT

According to the problem difficult to control and test the three degrees of freedom (3-DOF) hybrid vibrating screen motion parameters for more degree of freedom of motion, kinetic equations of 3-DOF hybrid vibrating screen which organization of a complete decoupling 3-DOF hybrid 2PRRR－P(2R) as the main body of vibration mechanism was established. The control system of excitation device were designed. And in order to collect screen surface kinetic parameters of the hybrid vibrating screen, a real-time feedback of test system was utilized based on three-dimensional displacement sensor. Experiments show that the system can be effective for controlling and giving feedback the motion parameters of vibrating screen , and vibrating screen to smooth movement, it also provide reference and basis for industrialized production of the multidimensional vibration screen.
Key words: Vibrating screen; Hybrid mechanism; Kinetic; Control system; Test system

E-055

Computer vision-based swing center testing method for flexible joint

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ABSTRACT

In view of the faults of traditional method, a computer vision-based swing center testing method for flexible joint was presented. The first step is to obtain original measurement date by a single industrial camera continuously capturing images of two circular marks which were fixed in the swinging object. The second step is to achieve stable and accurate multi-feature extraction in complex environment by a circular feature extraction method presented by our research group. And the final step is to obtain test results through the markers center coordinate and the swing center computing model. The experimental results indicate that the peak value (PV) error of this method is 1.6mm. This method is

effective and it is better than traditional testing methods.

Keywords: Computer Vision; Industrial test; Swing center; Feature extraction

E-076

Research on machine vision system of monitoring and detection injection molding processing

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ABSTRACT

With the mainstream ARM hardware platform match embedded Linux software system, the machine vision system was designed and transplanted for monitoring and detection injection molding processing. First, the initialization of the system can automatically extract objects which could be detected from the image of the process, and provides them to the user for selecting the monitored program and area. Then the system works, injection molding process is real-time monitored, compared to the standard image information, and the abnormality such as feeding stagnation, excessive wear, parts ectopic, product defects etc. will be detected and system will stop the injection machine and alarm.
Keywords: real-time monitored; automatically extract; embedded; detect abnormality

E-079

Design of Belt Conveyor Electric Control Device Based on CC-Link Bus

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ABSTRACT

In view of problem of the existing coal mine belt conveyor is no field bus communication function, two levels belt conveyor electric control system design is proposed based on field bus. Two-stage belt conveyor electric control system consists of operation platform, PLC control unit, various sensors, alarm device and the water spraying device. The error protection is realized by PLC programming，made use of CC-Link bus technology，the data share and the cooperative control came true between host station and slave station. The real-time monitor was achieved by the touch screen program. Practical application shows that the system can ensure the coalmine production，and improve the automatic level of the coalmine transport equipment.

Keywords: CC-Link，belt conveyor，PLC, electric control device

E-132

Design of Mine-used DC Carrier Telephone Based on STM32

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ABSTRACT

Abide by the design principles of mine intrinsically safe circuit, according to the need of underground communication in coal mine, the paper proposed a design scheme of DC carrier telephone which can dial. The design circuit of the telephone is introduced in detail. The telephone's voice signals are generated by the microphone. After enlarged then the voice signals are modulated to frequency signals by LM567 chip. The frequency signals are coupled by transformer and then transmitted by 12V DC power supply line to the other voice terminals. In the voice terminal the signals are demodulated by LM567 demodulation circuit and enlarged by LM386, then，the amplified audio signals are output from a speaker. The dialing circuit is designed based on the STM32 MCU. The dial information is transmitted to the other telephone terminals by CAN bus. The measured distance calls is greater than 2000m, volume is larger than 85dB, good results.

Keywords: DC carrier, telephone, STM32, CAN bus, LM567

E-092

Research of on-line monitoring method for insulation condition of power transformer bushing

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ABSTRACT

The power transformer is the key equipment of the power system; its insulation condition will directly influence the security and reliability of the power system. Thus, the on-line monitoring of power transformer is urgently required in order to guarantee the normal operation of the power system. Moreover, the dielectric loss factor is a significant parameter reflecting the condition of transformer bushing, so the on-line measurement of dielectric loss factor is really important. In this paper, the phase-to-phase comparison method is selected as the on-line monitoring method based on the overall analysis and discussion of the existing on-line monitoring methods. At first, the harmonic analysis method is utilized to calculate the dielectric loss of each phase of the three-phase transformer bushing, and then the differences of dielectric loss between every two phases are calculated and analyzed. So the insulation condition of each bushing could be achieved based on the careful analysis of different phase-to-phase dielectric loss. The simulation results of phase-tophase comparison method are carried out in this paper, and the validity is verified. At last, this method is utilized in anactual equipment of on-line monitoring.

Keywords: transformer bushing, dielectric loss factor, phase-to-phase comparison method, on-line monitoring method

E-093

Research of On-line Detection System for Power Capacitor

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ABSTRACT

The hidden danger exists in the power capacitor of power system due to long-time operation under the environment of high voltage. Thus, it is possible to induce serious fault, and the on-line detection system is urgently required. In this paper, two methods of the on-line detection system are compared in order to realize the better real-time condition detection. The first method is based on the STM microprocessor with an internal 12 bit A/D converter, which converts analog signals which is arrived from the sample circuit into digital signals, and then the FFT algorithm is used to accomplish the measurement of the voltage and current values of the capacitor. The second method is based on the special electric energy metering IC, which can obtain RMS (Root Mean Square) of voltage and current by processing the sampled data of the voltage and current, and store RMS of voltage and current in its certain registers. The operating condition of the capacitor can be obtained after getting the values of voltage and current. By comparing the measuring results of two methods, the second method could achieve a higher measurement accuracy and more simple construction.
Keywords: Power capacitor; On-line detection; STM microprocessor; Electric energy metering IC

E-098

Research of On-line Monitoring Equipment for Power Capacitor based on Wireless Sensor Network

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ABSTRACT

As the main electrical component for the reactive power compensation, the power capacitors are widely applied in many fields. And since the insulation condition of power capacitor could be identified accurately by using the on-line monitoring system, it attracts more and more attentions in recent years.
In this paper, a novel on-line monitoring equipment for power capacitor based on wireless sensor network is presented. The operation data which includes the current and voltage of every capacitor is collected at first, and then the FFT is utilized to calculate the amplitude and phase of every signal, thus the insulation condition and the fault symptom could all be diagnosed accurately by analyzing the FFT results. In order to realize the effective isolation and the reliable communication between the sensing part and the merging unit, the wireless sensor network is adopted. The high reliability and transmission rate could be realized by using 2.4GHz UHF and 5GHz ISM radio bands. Thus the on-line monitoring system could be manufactured, and the lab test is carried at last. The testing results illustrate that this system could satisfy the requirement of on-site real-time measurement.
Keywords: online monitoring; FFT; wireless sensor network; isolation; shunt high voltage capacitors bank

E-135

Measuring Method of CCD Installation Verticality Based on Own System of Intelligent Laser Cutting Machine

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ABSTRACT

The installation verticality between the optical axis of CCD and the working plane of intelligent laser cutting machine is one of the most important factors in determining image quality of the processed object which comes from computer vision system. In this paper, an innovative method is proposed which can make it possible to use the equipment of own system of intelligent laser cutting machine to detect installation verticality between the optical axis of CCD and the working plane. Experimental results show that the method presented in this paper is a feasible solution for measuring the installation verticality between the optical axis of CCD and the working plane of intelligent laser cutting machine.
Keywords: laser cutting, image processing, verticality detection

F-030

Design and Stability of the Three Degrees of Freedom Hybrid Damping Pantograph

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ABSTRACT

In view of the existing electric locomotive used single arm pantograph cannot withstand the lateral vibration at run time, collector head not timely release in scraping network accidents, such as shortcomings. Based on the topological theory of parallel robot, designed a {4PRPR-2PR} -P hybrid damping pantograph and electrical control system. Through the analysis of mechanism, that damping pantograph has complete decoupling three degrees of freedom; And the pantograph kinematics simulation analysis, concluded that direction of each degree of freedom movement damping characteristics. The simulation results indicate that: The parallel damping pantograph has three directions are consistent with theoretical analysis results; The motion of each direction are good, and damping performance is stable, and can effectively prevent the lateral vibration caused by electric locomotive accident; The separating mechanism of collector head can avoid scraping net accident.
Keywords: Hybrid damping, pantograph, kinematics, electronic control system

F-050

Study of the Pressing Machine Pressure Relief Characteristics Based on the AMESim

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ABSTRACT

Due to the high working pressure and the high frequency of working cylinder retracted transformation, when the pressing machine working cylinder stuck and retracted conversion, pressure shock was high in working cylinder cavity and flow pulsation was distinct in the pipeline, which not only reduced the life of the pressing machine, also seriously impacted on the machining precision and quality. Especially after the pressing machine applied load, high pressure oil

in work rod end cavity of working cylinder needed to be relieved in a relatively short time. In order to research and analyze the better pressure relief characters circuit , for the two types of pressure relief circuit of pressing machine, the paper conducted models, simulation and analysis, then contrasted the working cylinder rod velocity, rod acceleration and port pressure fluctuation according to the simulation results.
Keywords: pressing machine; pressure relief characters; modeling simulation; pressure fluctuation

F-111

THE THRUST AUTOMATIC MEASUREMENT SYSTEM OF （0.1～5)N THRUSTER

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ABSTRACT

We describe the micro-thrust automatic measurement system of stationary plasma thruster in the article, The system can carry a thruster and power supply less than 5kg weight. Thrust capacity is from 0.1 N to 5N,and thrust expend uncertainty is1%（k=2）.The system is based on the torsion balance principle. The thrust of the thruster makes torque to the pivot. This torque is balanced by the electromagnetic compensate torque generated by the measurement system. The rotation angle of this system is measured by the position sensor, the electromagnetic interference single comes from the speed sensor, the electromagnetic compensate torque is from the torque sensor. This is a closed circuit and automatic measurement system. The additional forces generated by the weight, the air supply system and the wires of the thruster have been separated from the micro-thrust in this system. The influence of deadweight, air supply system and power supply system of thruster on exact measurement of micro-thrust have been eliminated, so micro-thrust of thruster can be measured precisely and automatically .
Key words: thruster, micro- thrust, measurement，uncertainty

F-167

The influence of thin-film heater shape parameters on the electromigration

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ABSTRACT

In order to explore the influence of shape parameters on lifetime of Au heater, the accelerate life test (ALT) and finite element simulation was designed and conducted. The varieties of shape parameter was used in the ALT in which the applied current was 500mA and the test temperature was 150℃. The results showed that failure mode of all the different samples was open circuit, which caused by electromigration in this test conditions. According to the experimental and simulating results, the fusing break is appeared in the circular arc area where temperature gradient is the maximum. And the larger the radius, the later the failure. Correspondingly, lifetime of the thin-film heater was longer.
Keywords: Thin-film heater； Accelerated life test； Electromigration

G-004

The specular reflection in space-based space target detecting

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ABSTRACT

A mathematical model of space target illumination characteristics is established based on the basic theory of radiation by considering geometry, background, and material characteristics of the space target. Using the model, the spatial distribution of scattering light intensity from the space target is calculated with the modeling and blanking technique of target when being illuminated by the sun. The relations of specular reflection with the position, geometry, materials and other attributes of the space target are analyzed. Furthermore, the effect of specular reflection on space target detecting is discussed. A method of characteristic simulation of space target is presented. The simulation result indicates that polyhedral structure, mirror surface, or solar sail is easy to cause specular reflection. It shows the effect of specular reflection is helpful for space target detection and identification
Keywords: Space-based visible camera, Specular reflection, Space target, Optical characteristic

G-008

Grating Project Method For Surface With Step-height

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ABSTRACT

The grating projection measurement method has broad application in surface 3D topography measuring due to its measurement speed and accuracy. Handling with the grating, phase-shift method usually adopted for calculating the field phase, by projection scanning obtain more grating fringe image. The higher projection fringe density is, the higher measurement resolution can get. But as the result of projection gray value periodic changes, once the fringe period over single-period, absolute-phase will become wrapped-phase. Obtain the absolute phase always by means of unwrapping algorithm, while the traditional projection unwrapping algorithm based on phase continuity changing condition, not suitable for step-height measuring. Aiming at this problem, an unusual sub-step projection scanning method for variable width of grating period is proposed, according to the principle of minimum error, using the phase step by step estimation and connection method, get the high-density fringe projection absolute-phase directly.
Keywords : grating fringe processing; phase-shifting; step-height

G-019

Parallel common path phase-shifting interferometer with a digital reflective grating

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ABSTRACT

A parallel common path phase-shifting interferometer is presented using a digital reflective grating realized by a digital

micromirror device (DMD). The interferometer based on a modified Michelson architecture is constructed by a beam-splitter, a pinhole mirror, a digital reflective Ronchi grating and two lenses with same focal length to build a 4f optical system. In the interferometer, the pinhole mirror is used to low-filter the input-beam to act as reference beam, and the grating is used to introduce phase shift among +1, 0, and −1 diffraction orders of the input-beam to act as object beam. Then the specimen phase can be reconstructed from the three phase-shifted interferograms recorded in one shot using a normalize algorithm. The theoretical analysis and experiments are carried out to demonstrate the feasibility and accuracy of the proposed method.

Keywords: Quantitative phase imaging, phase-shifting interferometer, Michelson architecture, grating

G-020

Space camera optical axis pointing precision measurement system

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ABSTRACT

In order to realize the space camera which on satellite optical axis pointing precision measurement, a monocular vision measurement system based on object-image conjugate is established. In this system the algorithms such as object-image conjugate vision models and point by point calibration method are applied and have been verified. First, the space camera axis controller projects a laser beam to the standard screen for simulating the space camera's optical axis. The laser beam form a target point and has been captured by monocular vision camera. Then the two-dimensional coordinates of the targethttp://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E4%BD%BF%E7%94%A8%E5%8D%AB%E6%98%9F%E5%85%89%E8%BD%B4%E6%8E%A7%E5%88%B6%E5%99%A8%E4%BA%A7%E7%94%9F%E4%B8%80%E6%9D%9F%E5%AE%9A%E4%BD%8D%E5%85%89%E8%BD%B4%E5%B9%B6%E6%8A%95%E5%B0%84%E5%88%B0%E5%9F%BA%E5%87%86%E5%B1%8F%E5%B9%95%E5%BD%A2%E6%88%90%E7%9B%AE%E6%A0%87%E5%85%89%E6%96%91%EF%BC%8C%E5%B9%B6%E9%80%9A%E8%BF%87%E5%8D%95%E7%9B%AE%E8%A7%86%E8%A7%89%E7%9B%B8%E6%9C%BA%E5%AF%B9%E7%9B%AE%E6%A0%87%E8%BF%9B%E8%A1%8C%E points on the screenare calculated by a new vision measurement model which based on a looking-up and matching table, the table has been generated by object-image conjugate algorithm through point by point calibration. Finally, compare the calculation of coordinates offered by measurement system with the theory of coordinate offered by optical axis controller, the optical axis pointing precision can be evaluated. Experimental results indicate that the absolute precision of measurement system up to 0.15mm in 2m×2m FOV. This measurement system overcome the nonlinear distortion near the edge of the FOV and can meet the requirement of space camera's optical axis high precision measurement and evaluate.

Keywords: direction precision, monocular vision, object-image conjugate, calibration

G-045

Camera relative orientation in large field of view

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ABSTRACT

A new relative orientation method and local parameter optimization of the essential matrix for the large scale close range photogrammetry is presented in this paper to improve the measuring accuracy and stability, and expand the application scope of the system. For the matched images, according to the closed-loop polynomial algorithm, the essential matrix is initialized. In order to improve the accuracy and stability of the closed-loop polynomial algorithms, an iterative algorithm based on local parameter optimization is proposed. The relative exterior orientation parameters are solved from the essential matrix, and the only correct solution is determined by Cheirality constraints. The orientation experiment of the expandable truss microwave antenna profile measurement is carried out to verify its accuracy and reliability. Compared with the traditional methods, the new method has minimum projection error and the least iterations, and it will play a key role in improving the performance of the whole system.
Keywords: digital close range photogrammetry; large field of view; camera orientation; fundamental matrix; essential matrix

G-049

A Robust Method for Zero-order Fringe Localization in White Light Interference based AFM

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ABSTRACT

In white light interference based atomic force microscopy (AFM), the vertical displacement of probe is achieved by positioning analysis of the zero-order fringe on atomic force probe cantilever. Because of the influences from the asymmetric interference optical path, atomic force probe cantilever deformation and the optical and electrical noise disturbance, the interference fringe distortion is unavoidable, which may decrease the stability and accuracy for the zero-order fringe positioning analysis, always produce a large measurement deviation in white light interference based AFM.To solve the above problem, a robust method for zero-order fringe localization is proposed based on wavelet transform and the Hilbert transform. Experimental results demonstrate that the proposed algorithm can effectively reduce the influence of interference fringe distortion on the result of zero-order fringe positioning, and greatly improve the robustness and accuracy of the zero-order fringe location in white light interference based FM.
Keywords: white light interference; atomic force probe microscopy; zero-order fringe; positioning analysis

G-064

The white light interference system based on Fourier transform

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ABSTRACT

In order to realize non-contact and nondestructive field measurements of micro/nano scale devices, the white light interference system based on NMM is constructed. The system is composed of a Michelson interference objective and the tested sample is driven by high precision motion platform of NMM. The interference images are acquired by charge

coupled device (CCD), the Fourier transform is used for processing the intensity of interference images to get surface morphology. For large step structure, the auto-focusing speed-variable scanning technique is presented. The calibrated standard step height of 49.921 μm±0.267 μm is measured, the 10 times repetitive test result of 49.931 μm and standard deviation of 0.026 μm are achieved. To verify the measuring ability of complex devices, the number on ink box is measured and three-dimensional reconstruction is conducted. The results show that high precision and fast measurements of micro/nano scale devices are realized based on the white light interference system with Fourier transform.
Keywords: white light interference, speed-variable scanning, Fourier transform, standard step height

G-075

A flexible method for calibrating external parameters of two cameras with no-overlapping FOV

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ABSTRACT

A new flexible method to calibrate the external parameters of two cameras with no-overlapping field of view (FOV) is proposed in our paper. A flexible target with four spheres and a 1D bar is designed. All spheres can move freely along the bar to make sure that each camera can capture the image of two spheres clearly. As the radius of each sphere is known exactly, the center of each sphere under its corresponding camera coordinate system can be confirmed from each sphere projection. The centers of the four spheres are collinear in the process of calibration, so we can express the relationship of the four centers only by external parameters of the two cameras. When the expressions in different positions are obtained, the external parameters of two cameras can be determined. In our proposed calibration method, the center of the sphere can be determined accurately as the sphere projection is not concerned with the sphere orientation, meanwhile, the freely movement of the spheres can ensure the image of spheres clearly. Experiment results show that the proposed calibration method can obtain an acceptable accuracy, the calibrated vision system reaches 0.105 mm when measuring a distance section of 1040 mm. Moreover, the calibration method is efficient, convenient and with an easy operation.
Keywords: Spheres, calibration, no-overlapping, flexible

G-078

Development of an AOI system for chips with a hole on backside based on a frame imager

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ABSTRACT

Defects exist for a few of IC chips during fabrication and packaging. The cost for follow-up processes can be reduced if chips with defect size of impacting chip quality can be inspected and removed during the earlier sorting process. Products will be more cost-effective and competitive. According to inspecting requirements of customer's microphone chips, developed AOI system has to detect the boundary flaws and hole-inside defects with size of greater than criteria

from chip backside. Both the length and width of chip size are less than 5 mm and there's depth difference between surfaces of chip backside and hole-inside membrance. Thus image acquisition device is designed and implemented by an area scan imager, a telecentric lenses and a coaxial LED lighting module. Thus we can neglect the image radiometric and geometric calibration, and keep off the shadow inside the rim of hole. An algorithm to detect defects and derive their size based on the edge pixels statistic distribution and binary chip edge image is selected. Our AOI system therefore can meet the requirements of real-time defect inspection with high accuracy and performance.
Inspection system has the spatial resolution of 5 m and FOV of 6.4 x 5.1 mm. And defect inspection can be completed within 150 ms for the chip size of 2.5 x 3.0 mm. The processes of image acquisition and defect inspection can be accomplished during the chip sorting process to satisfy the real-time online inspection. Inspected chips are placed in GO/NG trays in real-time according to their quality. From the verification results compared with the ones by microscope, the inspection accuracy is better than system requirements. The over kill rate is less than 0.3% and 3% for chip boundary flaws and hole-inside defects respectively. But it still can't be inspected correctly for the hole-inside defects of only one membrance breakage. In the future, we will improve the illumination and detecting algorithm to solve this imperfection.
Inspection systems have been integrated into our customer's chip sorters, and successfully delivered to and accepted by end-users for online operations. Our system also can be accommodated to other customer's chip sorters with specific requirements for chip backside inspection during sorting process.
Keywords: chip-backside inspection, hole-inside defect, edge pixels statistic distribution, AOI

G-084

The Implementation Method of Stage Video Monitoring System Based on Network

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ABSTRACT

In view of the problems of inflexible saving and calling data and low reliability and being difficult to compate with other system for domestic stage video monitoring system, the authors proposed a video supervision and scheduling system of stage based on IP camera. And designed the structure of system, also tested the main functions of the system. The results show that this system can satisfy the modern stage performance effect and monitoring requirements.
Keywords: stage; network; video monitor; performance effect

G-091

Feature Matching Method for Uncorrected Fisheye Lens Image

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ABSTRACT

Due to large distortion exist in fisheye image, traditional matching algorithms cannot be directly applied to the fisheye

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image matching, therefore proposed a matching algorithm based on uncorrected fisheye images. This algorithm adopts MSER and CSLBP local feature descriptor. The two uncorrected fisheye image which collected by binocular vision system were described by using the principle of epipolar constraint firstly, and then adopted MSER regional operators to detect and ellipse fitting, use CSLBP descriptors to describe the features of MSER. Finally to exclude the mismatching points of initial match, adopt random sample consensus (RANSAC) algorithm to full fill exact match. Experiments show that the method has a good effect on the uncorrected fisheye image matching.
Keywords: Feature matching, MSER, CSLBP, Fisheye lens image

G-105

Effect of Nonlinearity by Polarization Beam Splitter in the double passage Heterodyne Interferometer

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ABSTRACT

In the heterodyne interferometric measuring system, the measuring result is often disturbed by the nonideal properties of optical components which are important sources of error. In the double passage heterodyne interferometric measuring system, the nonlinearity error caused by the transmission coefficient including transmissivity and reflectivity, and azimuthal error of polarization beam splitter (PBS) is analyzed. The mathematical model for nonlinearity error is established and simulated by using Matlab. The simulation results show that the nonlinearity error caused by the transmissivity and reflectivity of PBS in the double passage heterodyne interferometer is minor and can be ignored. When the reflectivity is 0.90 and the transmissivity of PBS reduces from 0.99 to 0.88, the nonlinearity error increases from 0.0038nm to 0.0125nm. But the nonlinearity error is influenced by the azimuthal error greatly. Suppose that the PBS has ideal properties, when the azimuthal error ranging from 1° to 12°, the nonlinearity error of the displacement increases from 0.0153 nm to 2.2766 nm.
Keywords: double passage, heterodyne interferometer, polarization beam splitter, reflectivity, transmissivity, azimuthal error, nonlinearity error, Matlab

G-120

3-D image registration by novel region-based similarity matching for arbitrary object reconstruction

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ABSTRACT

This paper presents a novel approach to digitize, register and reconstruct 3-D objects by employing new region-based similarity matching for 3-D point clouds registration. A new algorithm is proposed by developing a new 3-D surface

descriptor, which represents the geometric properties of each subdivided region of the object underlying reconstruction for region matching as well as the strategy for 3-D image registration. The point clouds of the object being detected from an optical scanner are first segmented into subdivided surface regions by employing the region growing approach. The geometric invariant property of the point clouds in the oriented bounding box of each subdivided region is then extracted to establish its 3-D surface descriptor. Following this, the region-to-region correspondences between two neighboring sets of point clouds can be then accurately determined by correlating each descriptor of the subdivided region with its neighboring ones. By identifying the geometric relationship, an initial rigid transformation matrix is initially identified by the matching results and it is further refined by the Iterative Closest Point (ICP) algorithm for accurate image registration. Some critical experiments were performed to verify the feasibility and effectiveness of the approach. The results indicate that the proposed method provides a fast and effective technique to 3-D object reconstruction. The existing difficulties encountered in the global 3-D registration problem can be effectively resolved.
Keywords: Optical vision, 3-D image registration, 3-D descriptor, object reconstruction, Iterative Closest Point (ICP)

G-124

Computational Imaging for Precision Metrology

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ABSTRACT

Computational methods have been used extensively to analyze data generated from various precision measuring instruments. Many of such instruments involve the use of standard cameras to record the information. Recently there has been growing interest in developing new generation of imaging systems which provide greater information with in some cases minimal optics to record the scene from which different features can be gleaned. This paper will look at developments of such systems for precision 3D measurements and exemplify some recent novel computational imaging systems.

G-137

Experimental Research of Digital Image Correlation System In High temperature Test

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ABSTRACT

Digital Image Correlation (DIC) is a full-field technique based on white-light illumination for displacement and strain measurement. But Light spectrum on the sample surface at high temperature affect the quality of acquired speckle pattern images for traditional DIC measurement. In order to greatly minimize the blackbody radiation effect in high temperature measurement by using digital image correlation method, this paper proposes a two-dimensional ultraviolet digital image correlation system (2D UV-DIC) containing ultraviolet illuminant and ultraviolet band-pass filter. It is confirmed by experiments that this system has the capacity to image clearly at higher temperature in comparison with

DIC using filtered blue light system, and it can still obtain high quality images up to 1200℃. In addition, considering the heat disturbance that can't be ignored in actual high temperature measurement, this paper also proposes a method using air controller in combination with image average algorithm. By measuring the thermal strain and thermal expansion coefficient of the Austenitic chromium-nickel stainless steel specimen at different temperatures, it is confirmed that this comprehensive method has the advantages of strong anti-interference ability and high precision.
Keywords: high temperature measurement, digital image correlation method, heat disturbance, UV-DIC

G-139

Fish Body surface Data Measurement Based on 3D Digital Image Correlation

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ABSTRACT

To film the moving fish body in the glass tank, the light will be bent at the interface of air and glass, glass and water. On the basis of stereo vision and refraction principle, through establish the calculation model of 3D image correlation to reconstruct 3D coordinates of sample. When making speckle in fish body, a series of real-time speckle images of swimming carp body will be obtain by two high-speed cameras, instantaneous 3D shape and strain, etc of fish body will be reconstructed.
Keywords: 3D Digital Image Correlation, multi-medium, Fish, 3D shape, strain

G-142

Strain Analysis of Pressure Vessels contained Pits Based on Digital Image Correlation Method

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ABSTRACT

This investigation applied the digital image correlation technique (DIC) on a pressure vessel that contained several surface pit defects under high pressure. Data on the deformation of the defects and peripheral area is obtained by this method. The results show that the stress and strain increase with the depth among different pits and are the largest at the bottom of any given pit. This method has proven to be a good choice for this type of experiment, where elastic and plastic surface strains need to be measured. The DIC can satisfy the requirements of being in situ, in real time, full-field and make non-contact measurements with more accurate and obvious experimental results compared with traditional measurement methods and pressure vessel test regulations. Also, it is a new, effective way for monitoring defects in online pressure vessels as well as a reliable basis for pressure vessels' safety evaluation.
Keywords: digital image correlation; pressure vessel; pit defect; deformation

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G-151

3D printing of tissue-simulating phantoms as a traceable standard for biomedical optical measurement

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ABSTRACT

Optical phantoms are commonly used to validate and calibrate biomedical optical devices in order to ensure accurate measurement of optical properties in biological tissue. However, commonly used optical phantoms are based on homogenous materials that reflect neither optical properties nor multi-layer heterogeneities of biological tissue. Using these phantoms for optical calibration may result in significant bias in biological measurement. We propose to characterize and fabricate tissue simulating phantoms that simulate not only the multi-layer heterogeneities but also optical properties of biological tissue. The tissue characterization module detects tissue structural and functional properties in vivo. The phantom printing module generates 3D tissue structures at different scales by layer-by-layer deposition of phantom materials with different optical properties. The ultimate goal is to fabricate multi-layer tissue simulating phantoms as a traceable standard for optimal calibration of biomedical optical spectral devices.
Keywords: Biomedical optical measurement, Tissue phantoms, 3D printing, Absorption, Scattering

G-156

Design of a Multi-scale Optical Lens

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ABSTRACT

The technology of multi-scale optical systems could be used to achieve a balance of the field-of-view and F-number, and helpful enhance the system image quality. This paper designed a multi-scale optical lens, and finished the work of demonstrating theoretically the feasibility of curved image together with the array lens. An idea has been proposed in this paper, using the approximately concentric chief rays combining with balance aberrations in each channel of the array lens to alleviate the aberrations of the whole optical system. Lastly, we designed a specific optical path and completed the experimental analysis. Experimental results show that the optical layout of the multi-scale optical lens can achieve a field of view of 60 degree while the aberration balance is well.
Keywords: Multi-scale, curved image area, optical design, concentric

G-157

A Machine Vision Based Method of High-precision Measurement of the Size of Workpiece

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ABSTRACT

Workpiece's posture and size in pixel level can be determined through optimization of the internal parameters of the camera, utilizing the enclosing rectangle method based on rotation axis to position the workpiece. After selecting ROI of the object, the sub-pixel edge of workpiece is extracted using the bilinear interpolation algorithm. Hessian paradigm line fitting is utilized to find the object edge accurately. The industrial camera with 5 million pixels is used, and the sizes from 80mm to 150mm of the workpiece are measured under the condition of panorama shooting, with measurement repeatability reaching 0.015mm.
Keywords: Internal parameters of camera; rotation axis; enclosing rectangle; bilinear interpolation algorithm; size measurement

G-163

An improved differential box-counting method of image segmentation

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ABSTRACT

The fractal dimension of image is an important quantitative traits, can be widely used in image analysis. In this paper, the differential box-counting method on the fitting line accuracy is improved that make the calculated fractal dimension error be smaller. And, regard the fractal dimension as a parameter, use the ostu algorithm to screw image segmentation. The segmentation image using by improved differential box-counting method is thinner, less impurities, clearer target outline, better segmentation effect.
Keywords: fractal dimension; differential box-counting method; Ostu algorithm

H-037

Oscillation characteristics of force signal measured by piezoelectric crystal dynamometer during single diamond grit scratching process

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ABSTRACT

The scratching force is a critical factor to evaluate the characteristics of single diamond grit scratching on the workpiece. It is commonly measured by piezoelectric crystal dynamometer. The force signal with low scratching speed shows a semi-sinusoidal variation in a single scratch. However, the force signals exhibit to be oscillation at high scratching speed. Experimental study was proposed to interpret why the force signals oscillate during the scratching process. A precise multicomponent dynamometer (Kistler 9119AA2) is employed in the force measurement of single diamond grit scratching on pure copper. The frequencies of the oscillation section of force signals with different scratching parameters are calculated by Fast Fourier Transform. The experimental results show that higher scratching speeds and larger depths of cut have lead to larger oscillation amplitudes of the force signals. The frequencies of oscillation section

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of force signals range in 2950-3200 Hz. The errors of experiment time and calculation time for the first semi-sinusoidal force signals are from 0.25% to 8.11%. The first semi-sinusoidal force signal is the actual scratching force. The strong impact by diamond grit scratching at a high speed has lead to a self-sustained oscillation piezoelectric crystal plate. The oscillation of force signal during the scratching process has little effect on the measuring accuracy of the dynamometer.
Keywords: single diamond grit, scratching, force measurement, signal oscillation

H-060

A Crack Extraction Algorithm based on Improved Median Filter and Hessian Matrix

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ABSTRACT

Aiming at the problem of existing crack extraction algorithms which are difficult to achieve fast and accurate crack extraction of image, an algorithm of crack detection based on Median Filter and Hessian Matrix is proposed. Firstly, median filter of crack gray image in 4 directions, Level, 45 degree, vertical and -45 degree, is conducted, by which noises are removed and roughly extracted crack is obtained. Then according to the Hessian matrix feature of extracting image linear feature, convolution of Differential operation of the Hessian matrix and is adopted, and crack is further extracted through eigenvalues response and Changing standard deviation of Gaussian function. The proposed algorithm validity is verified by comparison with other crack extraction algorithm. The results show that this algorithm has obvious accuracy rate in crack extraction.
Keywords: Median Filter; Hessian Matrix; Gaussian Function; Eigenvalue

H-100

The Discussion of Integer Coefficients Comb Filter to Suppress Power Frequency Interference

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ABSTRACT

As the equipment based on Embedded Systems always run into the interference of 50Hz frequency signal, we usually adopt digital filters to filter 50Hz frequency signal and reserve useful signals. But in order to meet the requirements for real-time processing, we hope the transfer function of the filter will be as simple as possible and the coefficient is integer. This article discusses the design methods of integer coefficients comb filter and gives out two integer coefficients comb filters which meet the requirements for real-time processing.
Keywords: Power Frequency,Comb Filter,Notch filter, Transfer function.

H-129

Study on Fluorescence Spectra of Thiamine, Riboflavin and Pyridoxine

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ABSTRACT

This paper presents the intrinsic fluorescence characteristics of vitamin B1, B2 and B6 measured with 3D fluorescence Spectrophotometer. Three strong fluorescence areas of vitamin B2 locate at λex/λem=270/525nm, 370/525nm and 450/525nm, one fluorescence areas of vitamin B1 locates at λex/λem=370/460nm, two fluorescence areas of vitamin B6 locates at λex/λem=250/370nm and 325/370nm were found. The influence of pH of solution to the fluorescence profile was also discussed. Using the PARAFAC algorithm, 10 vitamin B1, B2 and B6 mixed solutions were successfully decomposed, and the emission profiles, excitation profiles, central wavelengths and the concentration of the three components were retrieved precisely through about 5 iteration times.
Keywords: Thiamine/Vitamin B1, Riboflavin/Vitamin B2, Pyridoxine/Vitamin B6, Fluorescence Spectra, PARAFAC

H-133

Analysis of acoustic emission signal during ultrasonic vibration assisted scratching glass

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ABSTRACT

The characteristic of acoustic emission（AE） signal during single diamond scratching glass with ultrasonic vibration was investigated in this study. Firstly, influence of ultrasonic vibration to the AE signal waveform diagram was studied. The amplitude of the AE with ultrasonic vibration assisted scratching (UVAS) is greater than the ordinary scratching and accompanied a very obvious phenomenon of low frequency modulation. Secondly, by analyzed peak frequency distributions of AE signals, the peak frequency of UVAS has been found generally higher than ordinary scratching. Meanwhile the peak frequency distribution increased with the ultrasonic vibration frequency increasing in the experiment. Lastly, based on wavelet packet decomposition algorithm, the energy ratio of every frequency band signal was extracted as characteristic quantity to analyze ultrasonic vibration's influence on AE signal in data analysis software. The results showed that the main difference of AE signal's energy distribution between the UVAS and ordinary scratching existed in first frequency band, and the energy distributions of UVAS were more concentrated. The energy distribution rage of the AE signals became wider when the amplitude of applied ultrasonic vibration was increased.
Keywords: Ultrasonic vibration, Single grain, Acoustic emission, Wavelet，scratch，hard and brittle material

H-134

Weak Signal Detection based on the New Fractional Order Bistable System

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ABSTRACT

Stochastic resonance as a means of signal detection and enhancement, is always based on the general simple bistable system, this research extend the general one into a new complex fractional order bistable system, which is established on the over-damped fractional Langevin equation, the dynamic characteristic of the new system is analyzed by simulation, the generation and enhancement of stochastic resonance as well as its relation with the internal parameters is studied. The system when applied with weak periodic signal and external noise is also researched, we found that the stochastic resonance phenomenon can be generated and improved by changing the fractional order, frequency of input periodic signal and the external noise, the power spectrum of weak signal being detected is boosted thus making it more easily to be detected.
Keywords: stochastic resonance, over-damped fractional Langevin equation, weak signal detection, new bistable system

H-136

Noise Analysis of Infrared Touch Overlay and its Application on Kalman Filter

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ABSTRACT

Infrared touch overlay has some problems in multi-touch recognition and trajectory smoothness. In order to deal with these problems, this paper adjusts the Kalman filter for infrared touch overlay. Before the application, it estimates the noise of process and measurement. It analyzes the process noise and measurement noise from test of three different touch trajectories. And then the paper choses the proper parameter for the Kalman filter on infrared touch overlay. The experimental results demonstrate that the Kalman filter with the noise parameter works much better in filtering of the infrared touch overlay's track, compared to the original recognition algorithm.
Keyword: Kalman filter, Infrared Touch Overlay, Process Noise, Measurement Noise

H-138

Response of piezoelectric laminated micro plates under the excitation of an ultrasonic wave

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ABSTRACT

This study presents the electromechanical response of a piezoelectric laminated micro plate under the excitation of an ultrasonic wave. The laminated plate consists of a piezoelectric layer (AlN), an elastic layer (SiO2) and two electrode layers (Au and Pt). Since the whole thickness of the plate is in micro scale, the size dependence of the dynamic behavior of the plate is evaluated using the couple stress theory. The results show that the bending rigidity of the micro plate

increases when the size effect is considered and the amplitude of output of electric charge and voltage are reduced accordingly when the plate is excited by ultrasonic wave. Also the resonant frequency of the laminated plate increase because of the change of the bending rigidity of the plate. The analysis results can provide a reference for the design of micromachined piezoelectric sensors.

Keywords: electromechanical response; micro, piezoelectric laminated plate, couple stress theory

H-140

Research on double pulse laser induced plasma temperature and electron density of iron alloy

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ABSTRACT

The plasma temperature and electron density is an important content of the research. It is the study the mechanism of laser induced breakdown. The experiment with two Nd:YAG pulse laser induced iron alloy plasma obtained the 250~370nm spectrum diagram. Double pulse spectra and single pulse spectra are compared, the electron density of double pulse is $2\times10^{17}\,cm^{-3}$ by Lorentz linear fitting; it is 3 higher than single pulse. The plasma temperature of double pulse is $1.3\times10^{4}\,K$ by using Saha-Boltzmann multi line graph method. LIBS double pulse laser advantages over single pulse by the experimental results of electron density and plasma temperature and delay time relationship. Finally, based on the experimental results confirm the measuring time is in local thermal equilibrium plasma, the plasma state satisfies the sufficient condition experiment calculation method.

Keywords: LIBS; double pulse; electron density; plasma temperature

H-141

An Optimal Algorithm For Infrared Touch Overlay Based On Extended Kalman Filter And The Data Fusion

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ABSTRACT

Current infrared touch overlay has problems on the touch point recognition which bring some burrs on the touch trajectory. This paper uses the target tracking algorithm to improve the recognition and smoothness of infrared touch overlay. In order to deal with the nonlinear state estimate problem for touch point tracking, we use the extended Kalman filter in the target tracking algorithm. And it also uses the data fusion algorithm to match the estimate value with the original target trajectory. The application experiment results of the infrared touch overlay demonstrate that the proposed target tracking approach can improve the touch point recognition of the infrared touch overlay and achieve much smooth tracking trajectory than the original tracking approach.

Key word: Infrared Touch Overlay, Target Tracking Algorithm, Extended Kalman Filter, Data Fusion, Smooth

I-001

Study on the Method of Error Separation and Compensation based on Multiple Signal Superposition for Time Grating Angular Displacement Sensor

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ABSTRACT

A method of error separation on the principle of multiple signal superposition was introduced for time grating angular displacement sensors. According to the theory of error compensation, the accuracy of time grating sensors can be improved by compensating the separated errors. Errors of time grating angular displacement sensors caused by stators and rotors during manufacturing were separated and majority long-periodic and short-periodic errors were removed using this method. Thus, error compensation model can be established for these separated errors using the method of harmonic analysis. Circular indexing errors caused by slots of stators and rotors of time grating sensors can be compensated using this model. The accuracy was improved significantly to a field-type time grating by the error compensation model. The precise is 2.8″ after calibrating. Experiments prove that the method of error separation is very effective for removing indexing errors and the established error compensation model shows obvious effect in calibrating errors of time grating angular displacement sensors.

I-033

Measurement uncertainty sources analysis and verification of parasitic time grating sensors based on Ansoft Maxwell

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ABSTRACT

In order to guide the structure optimization of parasitic time grating, and to improve the quality of traveling wave signal and the measurement accuracy, the electrical traveling wave equation was detailed derived according to the structure and signal generation principle of parasitic time grating. The important electromagnetic parameters were analyzed by Ansoft Maxwell to determine the main uncertainty sources by using the control variable method. The simulation results show that excitation signal frequency, the gap width, the relative area of the probe and the rotor are the major factors which influence the angular measuring accuracy of parasitic time grating sensor. The number of coils, the excitation signal amplitude, the length of core are secondary factors. The acquired results can be used to do the further research on the structure optimization, error correction and uncertainty analyzing of parasitic time grating.

Keywords: parasitic time grating; traveling wave equation; electromagnetic parameter analysis; primary and secondary influence factors; angle-measuring accuracy

I-048

Hydrostatic Weighting Method for Calibration of Glass Hydrometer

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ABSTRACT

Glass hydrometer can effectively measure the density of liquids. A density calibration equipment with a silicon crystal ring has been developed for calibration of glass hydrometers. The silicon ring as a standard solid density, is used for measuring the density of working liquid by hydrostatic weighing method. The working liquid is n-tridecane with stability and low surface tension. According to the measurement of the density of working liquid, using hydrostatic weighing method again, the buoyancy of working liquid acting on glass hydrometer is measured to calibrate the scale reading of glass hydrometer. The calibration system automatically align the scale of hydrometer and liquid surface, using CCD image measurement system, with positioning accuracy of 0.01 mm. The temperature stability of working liquid within 24 hours is falling in to 10 mk. According to twice glass hydrometer weighing can calculate the correction value of the current scale. In order to verify the validity of the principle of the hydrostatic weighing method of glass hydrometer calibration system, for measuring the density range of (770-790) kg/m3, with a resolution of 0.2 kg/m3 of hydrometer. The results of measurement compare with the Physikalisch-Technische Bundesanstalt(The Physikalisch-Technische Bundesanstalt) ,verifying the validity of the calibration system.
Keywords: hydrostatic weighing; hydrometer; silicon crystal ring; calibration

I-057

Errors analysis of dimensional metrology for internal components assembly of EAST

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ABSTRACT

The precision of dimensional measurement plays an important role in guaranteeing the assembly accuracy of its internal components during the upgrading phase of EAST device. In this paper, the experimental research and analysis were done based on three dimensional combined measurement systems, combining Laser Tracker, flexible Measure ARM and measurement fiducials network, which are used for alignment and measurement of EAST components during the assembly process. The error sources were analyzed, e.g. temperature, gravity, welding, and so on. And the effective weight of each kind of error source was estimated by the simulation method. Then these results were used to correct and compensate the actual measured data, the stability and consistency of the measurement results was greatly improved in different measurement process, and the assembly precision of the EAST components was promised.
Keywords: Error analysis; Measurement errors; Measurement uncertainty; Assembly precision; Correction and compensation of error.

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I-089

Research of Position Measuring System for High Voltage Switchgear

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ABSTRACT

The accurate measurement for the contact position is the key part for the realization of on-line monitoring equipment of the high voltage switchgear. The speed and trip of the switchgear could also be obtained based on the position measurement. Thus, the health level and the operation status could be evaluated, the insulation condition and the fault symptom could also be identified.
In this paper, the on-line measuring principle for the contact position is presented at first. The indirect measuring method is adopted, and the incremental photoelectric encoder is utilized to realized the measurement of angular displacement. The position could be calculated by establishing the relationship between the angular displacement and the contact linear displacement. After that, the technical difficulties of the on-line measuring system are demonstrated. The selection of encoder and communication protocol, the difficult parts of hardware design and software design are all discussed deeply. The lab test of the whole measuring system is processed at last, the measuring results is satisfactory. It will provide powerful support for the realization of on-line monitoring equipment of the high voltage switchgear.
Keywords: high voltage switchgear, incremental photoelectric encoder, measurement of angular displacemen

I-090

Calibration of sound velocimeter in pure water

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ABSTRACT

Accurate measurement of sound speed is important to calibrate a sound velocity profiler which provides real-time sound velocity to the sonar equipment in oceanographic survey. The sound velocity profiler calculates the sound speed by measuring the time-of-flight of a 1 MHz single acoustic pulse to travel over about 300 mm path. A standard sound velocimeter instrument was invited to calibrate the sound velocity profiler in pure water at temperatures of 278,283, 288, 293, 298, 303 and 308K in a thermostatic vessel at one atmosphere. The sound velocity profiler was deployed in the thermostatic vessel alongside the standard sound velocimeter instrument and two platinum resistance thermometers (PRT) which were calibrated to 0.002k by comparison with a standard PRT. Time of flight circuit board was used to measure the time-of-flight to 22 picosecond precision. The sound speed which was measured by the sound velocity profiler was compared to the standard sound speed calculated by UNESCO to give the laboratory calibration coefficients and was demonstrated agreement with CTD-derived sound speed using Del Grosso’s seawater equation after removing a bias.
Keywords: calibration, sound velocimeter, tapped delay line method, thermostatic vessel, ultrasonic

J-023

Online Measurement and Control of Natural Gas Based on Raman Spectroscopy

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ABSTRACT

Online analytical instruments are increasingly widely applied to various production facilities of industrial process. The Raman spectrum analyzer is one of the typical representatives of online measurement, has been widely used in chemical,environment, biological, medical, court and identification science, geology, material, oil and other fields of study. With the rapid development of Chinese economy, the demand for fossil fuels has also been growth, so how to use the Raman spectra to achieve the high precision and quick measurement of the concentration of each component in natural gas has become a major research focus. So finally how to measure the intensity of Raman spectral in high precision becomes one of the main points, that means it is vital to process the base of natural gas Raman spectra and which directly determines the accuracy of gas measurement. This paper proposes a new method to acquire the base which based on the above mentioned points so much and on the designed Raman spectrometer structure. The method which based on the Raman laser gas analysis system shown in following figure 1 using real-time differential to eliminate the basement by adjusting the black baffle position up and down. By this way, intensity of gas signal spectra was obtained. Compared to the method of using argon basal calibration, the hardware operation to preprocess the basement is more simple, what just need to do is to adjust the electromagnetic valve to control the upper and lower position of panel. It has important practical application value with saving cost and easy to implement.
Key words: Online measurement; Raman spectra; Hardware operation;Differential;Basement elimination

J-096

Study on the Abnormal Data Rejection and Normal Condition Evaluation applied in Wind Turbine Farm

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ABSTRACT

The condition detection of wind turbine is always an important problems which attract more and more attentions because of the rapid development of wind farm. And the on-line data analysis is also difficult since a lot of measuring data is collected.

In this paper, the abnormal data rejection and normal condition evaluation of wind turbine is processed. At first, since there are large amounts of abnormal data existed in the normal operationof wind turbine, which is probably caused by fault, maintenance downtime,power-limited operation and failure of wind speedsensor, anovelmethod is proposed to reject abnormal data in order to make more accurate analysis for the wind turbine condition.The core principle of novel method is to fit the wind power curves by using the scatter diagram. The data outside the area covered by wind power curves is the abnormal data. The calculation shows that the abnormal data is rejected effectively. After the rejection, the vibration signals of wind turbine bearing which is a critical component are analyzed and the relationship between the vibration characteristic value and the operating condition of wind turbine is discussed. It will provide the powerful supportfor the accurate fault analysis of wind turbine.
Keywords: data rejection, operating condition, curve fitting, vibration analysis

J-124

ADXL345 Acceleration Sensor for Vibration Intensity Detecting

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ABSTRACT

This paper introduces the basic characteristics of ADXL345 three-axis acceleration sensor, describes the design of Shaker shock detecting device based on ADXL345 three-axis acceleration sensor, Use the peak to peak value of acceleration data to evaluate strength parameters of the vibration table. The test system is constituted by ADXL345 and STC11L02, ADXL345 is used for capturing signal of shock .Data stored in the static RAM of STC11L02. The software flow would be started to process the data and evaluate the strength of the shock .The result and original data would be sent to the PC through the serial port. PC software is written based on environment of LabVIEW which can view the waveform of collected signal data, and verify lower machine's calculation through the PC software.
Key words： ADXL345; acceleration sensor chip; shock detect; LabVIEW; MCU

J-166

Influence of atmospheric turbulence on detecting performance of all-day star sensor

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ABSTRACT

All-day star sensor makes it possible to observe stars in all-day time in the atmosphere. But the detecting performance is influenced by atmospheric turbulence. According to the characteristic of turbulence in long-exposure model, the modulation transfer function, point spread function and encircled power of the imaging system has been analyzed. Combined with typical star sensor optical system, the signal to noise ratio and the detectable stellar magnitude limit affected by turbulence have been calculated. The result shows the ratio of aperture diameter to atmospheric coherence length is main basis for the evaluation of the impact of turbulence. In condition of medium turbulence in day time, signal to noise ratio of the star sensor with diameter 120mm will drop about 4dB at most in typical work environment, and the detectable stellar limit will drop 1 magnitude.
Key words: Star sensor; All-day; Atmospheric turbulence; long-exposure;