

PROCEEDINGS OF SPIE

Ninth International Symposium on Precision Mechanical Measurements

Liandong Yu
Editor

18–21 October 2019
Chongqing, China

Organized by
Hefei University of Technology (China)

Co-organized by
Chongqing University of Technology (China)
Beijing Information Science and Technology University (China)
Harbin Institute of Technology (China)
Chongqing Youth Federation for Science and Technology (China)

Sponsored by
International Committee on Measurements and Instrumentation (Hong Kong, China)
National Natural Science Foundation of China (China)
China Instrument and Control Society (China)

Published by
SPIE

Volume 11343

Proceedings of SPIE 0277-786X, V. 11343

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Ninth International Symposium on Precision Mechanical Measurements, edited by Liandong Yu, Proc. of SPIE Vol. 11343, 1134301 · © 2019 SPIE · CCC code: 0277-786X/19/\$21 · doi: 10.1117/12.2560514

Proc. of SPIE Vol. 11343 1134301-1

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIDigitalLibrary.org.

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in *Ninth International Symposium on Precision Mechanical Measurements*, edited by Liandong Yu, Proceedings of SPIE Vol. 11343 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

ISSN: 0277-786X
ISSN: 1996-756X (electronic)

ISBN: 9781510634589
ISBN: 9781510634596 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445

SPIE.org

Copyright © 2019, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$21.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/19/\$21.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

Publication of record for individual papers is online in the SPIE Digital Library.

**SPIE. DIGITAL
LIBRARY**

SPIDigitalLibrary.org

Paper Numbering: *Proceedings of SPIE* follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

Contents

ix	<i>Authors</i>
xiii	<i>Conference Committee</i>
xvii	<i>Introduction</i>

NINTH INTERNATIONAL SYMPOSIUM ON PRECISION MECHANICAL MEASUREMENTS

11343 02	Portable microscope imaging system for quantitative detection of pepsinogen II [11343-1]
11343 03	Compensation of nonlinear errors of phase-shifted fringes in phase measuring deflectometry [11343-3]
11343 04	Study on improvement of the accuracy of scanning electron microscope: energy dispersed spectroscopy quantitative analysis [11343-4]
11343 05	Measurement of squareness based on error separation and estimation of the uncertainty [11343-5]
11343 06	Two-dimensional angle measurement using dynamic modulation and the shape of the interference fringes [11343-6]
11343 07	Development of a virtual model of five-axis coordinate measuring machine [11343-8]
11343 08	A multi-pass interferometer for high resolution angular measurement [11343-9]
11343 09	Performance calculation and analysis of the novel flexure hinges [11343-13]
11343 0A	Research on machine vision measuring method for fine-pitch gears [11343-14]
11343 0B	A comparative study of MDH and zero reference model for geometric parameters calibration to enhance robot accuracy [11343-15]
11343 0C	The calibration method for robotic kinematic parameters based on articulated coordinate measuring machine [11343-16]
11343 0D	An absolute measurement method of time-grating angular displacement sensor [11343-17]
11343 0E	Error testing and compensation of the time-grating angle measurement system [11343-18]
11343 0F	High-performance eddy current displacement sensor for adaptive optical systems [11343-19]

- 11343 OG **The compensation of deformation measurement in large field of view based on digital speckle pattern interferometry** [11343-20]
- 11343 OH **Identification and classification of surface defects in polycrystalline diamond compact** [11343-21]
- 11343 OI **Parameter calibration of surface profile measurement system based on femtosecond laser** [11343-22]
- 11343 OJ **A simple method for minimum zone sphericity evaluation** [11343-25]
- 11343 OK **Misjudgment risk estimation for product quality total inspection based on measurement uncertainty** [11343-28]
- 11343 OL **Correlation verification of uncertainty sources for fan energy efficiency test based on Monte Carlo simulation** [11343-29]
- 11343 OM **Design and implementation of online measurement and control system for mold cavity temperature** [11343-30]
- 11343 ON **Research on AGV positioning and path planning technology based on ultra wideband** [11343-31]
- 11343 OO **Residual stress measurement of glass based on Muller matrix ellipsometer** [11343-32]
- 11343 OP **Design for performance test system of industrial robots** [11343-33]
- 11343 OQ **Calibration of a vision-based location system with Hybrid Genetic-Newton Method** [11343-37]
- 11343 OR **Comprehensive detection method of weld based on line structured light and weak magnetic detection** [11343-38]
- 11343 OS **Thermoelastic damping suppression method for MEMS resonant beam by introducing vertical slots** [11343-39]
- 11343 OU **Research on COD detection method based on UV-Vis spectroscopy** [11343-41]
- 11343 OV **Review on rotation angle measurement method for spherical joint** [11343-42]
- 11343 OW **Research of open-circuit fault simulation and diagnosis for wind power converter** [11343-43]
- 11343 OX **Research on multi-parameter detection method for environmental water quality** [11343-45]
- 11343 OY **Digital method for gear measuring data** [11343-46]
- 11343 OZ **Design and model of a XY parallel inertial drive mechanism based on piezoelectric bending actuators** [11343-47]
- 11343 10 **The verification method of steel tape based on image processing** [11343-48]

- 11343 11 **Research of distributed pump automatic test system** [11343-56]
- 11343 12 **An instrument for wall shear stress measurement** [11343-60]
- 11343 13 **Analysis and modeling of dynamic positioning error of CNC machine tool XY worktable** [11343-62]
- 11343 14 **A compact 4-DOF measurement system for machine tools** [11343-63]
- 11343 15 **Methane and hydrogen sensor based on photonic crystal waveguide** [11343-68]
- 11343 16 **Analysis of temperature anomaly of pitch motor based on SCADA data** [11343-72]
- 11343 17 **Moving target tracking and fast searching method based on template matching** [11343-75]
- 11343 18 **A wireless approach for acoustic emission sensing** [11343-76]
- 11343 19 **Analysis of yaw characteristics of wind turbines in mountain wind farm based on SCADA data** [11343-77]
- 11343 1A **Analysis of influencing factors on the accuracy of close-range photogrammetry system in blade model detection** [11343-78]
- 11343 1B **Research on wind turbine stator iron-core temperature calculation model** [11343-79]
- 11343 1C **Load analysis of wind turbine blade model based on digital image correlation method** [11343-80]
- 11343 1D **Non-diffraction bessel wave simulation based on angular spectrum concept** [11343-81]
- 11343 1E **Frequency modulation interference ranging method based on equal optical frequency subdivision resampling** [11343-82]
- 11343 1F **Research on correction method in AGV motion using inertial guidance and QR code** [11343-83]
- 11343 1G **Coaxial integrated design scheme of macro-micro composite actuator with large-stroke and high-precision** [11343-84]
- 11343 1H **Precision measurement of angle using digital speckle pattern interferometry** [11343-85]
- 11343 1I **Angular measurement based on vision based AGV** [11343-86]
- 11343 1J **Ultrasound Doppler signal simulation based on wavefront propagation** [11343-88]
- 11343 1K **Ultrasonic wave focusing on flexible array sensors in weld detection** [11343-92]
- 11343 1L **Development of laser radar imaging technology based on compressive sensing** [11343-93]

- 11343 1M **A novel method for broadband ultrasonic attenuation measurement in calcaneal quantitative ultrasound system** [11343-94]
- 11343 1N **Position error calibration of industrial robot based on binocular vision with reference length constraint** [11343-95]
- 11343 1O **Effective slip length at solid–liquid interface of roughness-induced surfaces with omniphobicity** [11343-97]
- 11343 1P **Novel triangular pattern generation method for fast and accurate three-dimensional shape measurement** [11343-99]
- 11343 1Q **Over-roll protection analysis of vertical shaft friction lifting system** [11343-101]
- 11343 1R **Research on intelligent rating method for metallographic structure based on deep learning** [11343-103]
- 11343 1S **The calibration of angular velocity deviation among full rotary circle** [11343-104]
- 11343 1T **Research on error model between position of measurement point and measurement accuracy in multilateral coordinate measuring system** [11343-105]
- 11343 1U **Prediction of weld penetration status based on sparse representation in fiber laser welding** [11343-106]
- 11343 1V **Calibration technology of length measurement accuracy of total station in automatic air refractive index compensation system** [11343-107]
- 11343 1W **Research on the method of simultaneous measurement of angular position and angular speed for time grating** [11343-108]
- 11343 1X **Optimization of influencing factors of camera distortion calibration** [11343-109]
- 11343 1Y **Finite element simulation of HIFU nonlinear medical ultrasound field** [11343-110]
- 11343 1Z **Research on three-dimensional positioning method of casing welds based on binocular vision** [11343-111]
- 11343 20 **Construction of a robust three-degree-of-freedom laser measurement system for measuring motion error of long-travel linear stages** [11343-112]
- 11343 21 **Springback measurement in micro W-bending** [11343-116]
- 11343 22 **Micro-milling cutter precise tool setting technology based on discharge sensing** [11343-120]
- 11343 23 **Study on discharge states detection method of VHF micro-EDM pulse generator used in polishing of optoelectronic device** [11343-121]
- 11343 24 **Spindle parallelism adjustment technology based on discharge sensing** [11343-122]

- 11343 25 **Calibration of cantilever length of non-orthogonal cantilever coordinate measuring machine based on the double reversal method** [11343-123]
- 11343 26 **Research on laser source drift with temperature of laser triangular displacement sensor** [11343-124]
- 11343 27 **Z-axis compensation analysis of vertical scanning white light interferometry system in horizontal moving** [11343-125]
- 11343 28 **Design of multi-bandpass filters in 3D display technology** [11343-126]
- 11343 29 **Measurement principle and structure optimization of two-dimensional time grating displacement sensor** [11343-128]
- 11343 2A **Effect of average speckle size on speckle interference fringe pattern** [11343-129]

Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Bao, Fengqing, 0G
Bian, Dian, 0I
Cai, Yindi, 20
Cao, Cong, 04, 05
Cao, Jiaming, 10
Chang, Yaqi, 0I
Chen, Cancan, 15
Chen, Guoyu, 09
Chen, Haixiu, 0U, 0X
Chen, Runbo, 12
Chen, Shuoyi, 11
Chen, Weijie, 0G
Chen, Ze-Yuan, 06
Cheng, Jie, 0I
Cheng, Qiangqiang, 0R
Cheng, Rongjun, 0J, 0S
Cheng, Xuemin, 1L
Cheng, Yinbao, 0K, 0L
Cui, Changcai, 0H, 0O, 27
Cui, Hao, 02
Cui, Lu-fei, 1G
Dai, Jie, 0M
Dai, Tianliang, 0Z
Deng, JiaYi, 1Q
Deng, Jinjun, 12
Dou, Mengmeng, 04
Du, Han, 1K
Du, Yijun, 21
Fan, FeiFei, 1Q
Fan, Kuangchao, 14, 20
Fan, Wei, 1K
Fang, Chuanzhi, 0J
Fang, Shi-xue, 06
Fang, Xiuzhi, 07
Feng, Baokai, 20
Feng, Shuai, 1D, 1J, 1M
Feng, Xugang, 07
Feng, Yu, 26
Feng, Zhihua, 0F
Fu, Huadong, 0K, 0L
Gao, Guanbin, 0P
Gao, Haoran, 0I
Gao, Shenping, 1Y
Gao, Sitian, 08
Gao, Tiande, 12
Gao, Yuzhang, 25
Gao, Zhonghua, 1W
Gu, Junlan, 1R
Gui, Lin, 16, 19
Guo, Bin, 1X
Guo, Chengcheng, 1Y
Guo, Hua, 0H
Han, Liang, 0V
Hao, Qun, 1L
He, Ming-zhao, 1V
He, Tao, 09
Hou, Yan, 0U, 0X
Hu, Biao, 0R
Hu, Bo, 22, 24
Hu, Fang, 1B
Hu, Penghao, 0V
Hu, XiaoFeng, 1I
Hu, Xiaohao, 0N
Huang, Lingxiang, 19
Huang, Lu, 08
Huang, Qiangxian, 0J, 0S, 14
Huang, Wenbin, 18
Huang, Xiaohui, 2A
Huang, Yao, 1S
Ji, Fang, 23
Jia, Huakun, 10
Jia, Minqiang, 05
Jiang, Chengyu, 12
Jiang, Wensong, 0N, 0Q
Jiang, Yizhou, 0C
Jin, Shiqun, 02
Jing, Qi, 23
Kang, ChuanShuai, 0B
Lei, Xianqing, 0A
Li, Cheng, 09
Li, Dongsheng, 1O
Li, Feng-jun, 0D
Li, Hongli, 0J
Li, Huihui, 0H
Li, Jian, 22, 23
Li, Jian-shuang, 1T, 1V
Li, Jianyuan, 22, 24
Li, Jiaying, 1X
Li, Li, 13
Li, Ling, 0K, 0L
Li, Mei-Xuan, 28
Li, Pengxia, 1W
Li, Ping, 1V
Li, Qi, 08
Li, Rui, 10
Li, Ruijun, 14
Li, Shaoliang, 03
Li, Shi, 08

Li, Wei, 08
 Li, Weixian, 1H
 Li, Xin, 1H
 Li, Yifan, 1O
 Li, Yihua, 1Q
 Li, Zhishuai, 0U, 0X
 Lin, Yonghong, 17, 1Z
 Ling, Qihui, 0W, 16
 Liu, Fei, 0P
 Liu, Guangmin, 23, 24
 Liu, Hai, 15
 Liu, Ji, 2A
 Liu, Jie, 0U, 0X
 Liu, Ming, 06
 Liu, Qi, 0N
 Liu, Shida, 0C
 Liu, Xiaoyu, 21
 Lu, Xiaolong, 21
 Luo, Jian, 12
 Luo, Zai, 0N, 0Q, 1F, 1I, 1X
 Lv, Zhongyan, 0B
 Lyu, Jing, 0K, 0L
 Ma, Binghe, 12
 Ma, Dan, 06
 Mei, Jian, 0J
 Miao, Dong-jing, 1N, 1T
 Mou, Chuan, 29
 Na, Jing, 0P
 Nan, Zhuojiang, 26
 Niu, Zhenqi, 03
 Ou, Jiahao, 17, 1Z
 Pan, Chengliang, 0F, 0Z
 Pang, Yongjun, 13
 Peng, Dong-lin, 0D
 Peng, Hu, 1D, 1J, 1M
 Peng, Siping, 03
 Qi, Yuhai, 0S
 Qiao, H. Y., 1M
 Qiao, Tiezhu, 25
 Qing, Yaoyao, 1A, 1C
 Qu, Bao-hua, 0D, 0E
 Qu, Xinghua, 1E
 Ren, Huan, 1Q
 Sang, Qi, 20
 Shi, Chao, 0Z
 Shi, Yushu, 08
 Shu, Chao, 1A, 1C
 Song, Pengcheng, 0S
 Song, Wanting, 1F
 Tang, Chuxin, 0V
 Tang, Pei, 1Q
 Tang, Qi-fu, 0E
 Tang, Shoufeng, 15
 Tang, Ying, 05
 Tang, Yingqi, 1F
 Tao, Wei, 26
 Tian, Porui, 1O
 Wan, Jialuo, 1W
 Wang, Chaoqun, 0J
 Wang, Chuanli, 09
 Wang, Dongxia, 0B
 Wang, Fan, 1S
 Wang, Hanbin, 0K
 Wang, Haoran, 15
 Wang, Jiangtao, 02
 Wang, Liyan, 0M
 Wang, Rong, 1U
 Wang, Xian, 0W, 16, 17, 1B, 1Z
 Wang, Xiaobo, 1Y
 Wang, Xiaoyi, 0A
 Wang, Xinrui, 1N
 Wang, Xuan-ze, 06
 Wang, Y., 0Y
 Wang, Yang-yang, 0D, 0E
 Wang, Yonghong, 0G
 Wang, Yuebing, 1Y
 Wang, Zhongyu, 0K, 0L, 0Q
 Wei, Yongmei, 1D, 1J
 Wei, Yuzhao, 02
 Wen, Xiulan, 0B
 Wu, Delin, 1Y
 Wu, Fan, 1H
 Wu, Jun, 0L
 Wu, Liang, 29
 Wu, Shuangle, 0G
 Wu, Sijin, 1H
 Xia, Guisuo, 0R
 Xia, Guo, 02
 Xia, Haojie, 0Z
 Xiao, Zhao, 19
 Xiong, Mei-jun, 1G
 Xu, Hui, 12
 Xu, Peng, 14
 Xu, Xueyang, 03
 Xu, Zhang, 25
 Xu, Zhenying, 1K, 1R, 1U
 Xue, Haifeng, 0U
 Xue, Zi, 1N, 1S
 Yan, Lei, 1L
 Yan, Yuchao, 12
 Yang, Binhe, 20
 Yang, Cheng, 27
 Yang, Fei, 0F
 Yang, Hongtao, 13
 Yang, Mingdai, 1B
 Yang, Rongguang, 0M
 Yang, Xuebing, 1B
 Yao, Lei, 1Y
 Yao, X. J., 0Y
 Ye, Jing, 0R
 Yu, Cao-feng, 1G
 Yu, Jiahua, 0O
 Yu, Jing, 1I
 Yu, Liandong, 0C, 0I, 0Z, 10
 Yu, Lixia, 2A
 Yuan, Weiran, 22, 24
 Yue, Longlong, 0J
 Zeng, Bing, 0W, 16
 Zhang, Binbin, 1E
 Zhang, Deqi, 18

Zhang, D. P., 0Y
Zhang, Fu-min, 1E, 1V
Zhang, Haitao, 25
Zhang, Hui, 0M, 11
Zhang, Jian, 04, 05
Zhang, Jiangzhou, 0X
Zhang, Jianyan, 07
Zhang, Liansheng, 0J, 0S
Zhang, Run, 0C
Zhang, Shiwen, 0P
Zhang, Shuai, 1T
Zhang, Si-Qi, 28
Zhang, Tian, 06
Zhang, Tian-heng, 0D, 0E
Zhang, Wei, 0W
Zhang, Wen, 15
Zhang, Wen-Ying, 28
Zhang, Xiangchao, 03
Zhang, Yang, 0M, 11
Zhang, Yin, 0B
Zhang, Yongbin, 22, 23, 24
Zhang, Yu, 13
Zhang, Yuanqi, 0V
Zhang, Zhibo, 18
Zhao, Dongsheng, 04, 05
Zhao, Hui, 26
Zhao, Huining, 10
Zhao, Linchao, 0V
Zhao, Qiancheng, 0W, 16, 19, 1A, 1B, 1C
Zhao, Qihan, 0G
Zhao, Shiping, 21
Zhao, Wenkai, 14
Zhao, Yibing, 0B
Zheng, Huiheng, 1Y
Zheng, Ji-hui, 1T
Zheng, Renhao, 1P
Zhong, Deqi, 18
Zhong, Siping, 18
Zhong, Ziqiang, 29
Zhou, Di, 11
Zhu, Anfeng, 16, 19
Zhu, Yifan, 03
Zuo, Heng, 0F
Zuo, Rong, 1R, 1U
Zuo, Xiaolin, 0A

Conference Committees

Honorary Conference Chairs

G. F. Jin, Tsinghua University (China)
S. H. Ye, Tianjin University (China)

Conference Chair

Z. H. You, Tsinghua University (China)

International Committee Chair

L. X. Yang, Oakland University (United States)

International Committee Co-chairs

H. Bosse, Physikalisch-Technische Bundesanstalt (Germany)
S. W. Kim, Korea Advanced Institute of Science and Technology
(Korea, Republic of)
K. C. Fan, Dalian University of Technology (China)
L. X. Gu, University of Nebraska-Lincoln (United States)
U. H. W. Brand, Physikalisch-Technische Bundesanstalt (Germany)
A. Ehemeyer, NTB Interstaatliche Hochschule für Technik Buchs
(Switzerland)
J. Kofman, University of Waterloo (Canada)
M. Schuth, Hochschule Trier (Germany)
M. Gu, Swinburne University of Technology (Australia)
W. Gao, Tohoku University (Japan)
R. Leach, National Physical Laboratory (United Kingdom)
P. Ott, Hochschule Heilbronn (Germany)
T. T. Chung, National Taiwan University (Taiwan, China)
W. H. Li, University of Wollongong (Australia)
C. L. Chu, Southern Taiwan University of Science and Technology
(Taiwan, China)
Y. J. Kim, Korea Advanced Institute of Science and Technology
(Korea, Republic of)
Y. Chugui, Russian Academy of Sciences (Russian Federation)

Organizing Committee Chair

L. D. Yu, Hefei University of Technology (China)

Organizing Committee Co-chairs

M. L. Dong, Beijing Information of Science and Technology University
(China)
X. K. Liu, Chongqing University of Technology (China)
J. Gao, Hefei University of Technology (China)

Organizing Committee Members

X. R. Xu, University of Science and Technology of China (China)
D. Wu, University of Science and Technology of China (China)
X. Zhang, Anhui University of Science and Technology (China)
Q. Yu, Huaqiao University (China)
F. J. Duan, Tianjin University (China)
J. B. Tan, Harbin Institute of Technology (China)
Q. B. Feng, Beijing Jiaotong University (China)
L. R. Qiu, Beijing Institute of Technology (China)
G. Z. Yan, Shanghai Jiaotong University (China)
J. R. Chu, University of Science and Technology of China (China)
Zh. Y. Wang, Beihang University (China)
X. P. Lou, Beijing Information of Science and Technology (China)
Z. Luo, China Jiliang University (China)
R. S. Lu, Hefei University of Technology (China)
Q. X. Huang, Hefei University of Technology (China)
P. H. Hu, Hefei University of Technology (China)
Y. H. Wang, Hefei University of Technology (China)
H. X. Deng, Hefei University of Technology (China)
H. J. Xia, Hefei University of Technology (China)
J. Zhang, Hefei University of Technology (China)
R. J. Li, Hefei University of Technology (China)
W. Sh. Li, Hefei University of Technology (China)

Program Committee Chair

X. H. Shi, Chongqing University of Tehnology (China)

Program Committee Members

Y. S. Gao, Hong Kong University of Science & Technology (China)
X. Wang, Tsinghua University (China)
Zh. Ouyang, Tsinghua University (China)
L. D. Yu, Hefei University of Technology (China)
M. Krystek, Physikalisch-Technische Bundesanstalt (Germany)
Q. B. Feng, Beijing Jiaotong University (China)
W. Q. Zhao, Beijing Institute of Technology (China)
Q. Hao, Beijing Institute of Technology (China)
X. H. Qu, Tianjin University (China)

J. B. Feng, Zhejiang University (China)
Z. Luo, China Jiliang University (China)
Z. Y. Shi, Beijing University of Technology (China)
W. H. Zhou, Chinese Academy of Science (China)
G. L. Dai, Physikalisch-Technische Bundesanstalt (Germany)
E. Peiner, Technische Universität Braunschweig (Germany)
D. L. Peng, Chongqing University of Technology (China)
S. Y. Liu, Huazhong University of Science and Technology (China)
Zh. Zh. Wei, Beihang University (China)
Zh. Y. Wang, Beihang University (China)
Ch. C. Cui, Huaqiao University (China)
L. J. Xu, Beihang University (China)
L. Q. Zhu, Beijing Information Science and Technology University (China)
A. G. Song, Southeast University (China)
Zh. M. Zeng, Tianjin University (China)
J. Liu, Harbin Institute of Technology (China)
B. Y. Chen, Zhejiang Sci-Tech University (China)
H. Zhao, Shanghai Jiao Tong University (China)
Y. C. Guo, Chongqing University (China)
D. H. Wang, Chongqing University (China)
J. Liu, North University of China (China)
H. Z. Liu, Xi'an Jiaotong University (China)
W. L. Liu, Huazhong University of Science and Technology (China)
Z. R. Chen, Chongqing University of Technology (China)

Conference Secretariats

M. Y. Kuang, Hefei University of Technology (China)
Q. Y. Liu, Hefei University of Technology (China)
X. A. Zhou, Hefei University of Technology (China)
Z. R. Chen, Chongqing University of Technology (China)
R. Zhang, Hefei University of Technology (China)
Sh. D. Liu, Hefei University of Technology (China)

Session Chairs

- 1 Opto-Electronic Measurement & Image Processing I
D. X. Hua, Xi'an University of Technology (China)
Zh. Y. Xu, Jiangsu University (China)
- 2 Length and Angle Measurement
P.H. Hu, Hefei University of Technology (China)
H. T. Yang, Anhui University of Science and Technology (China)

- 3 Micro-nano Metrology and MEMS
L. P. Yan, Zhejiang Sci-Tech University (China)
X. K. Liu, Chongqing University of Technology (China)
- 4 Opto-Electronic Measurement and Image Processing II
Q. B. Feng, Beijing Jiaotong University (China)
J. Kofman, University of Waterloo (Canada)
- 5 Sensor Technology and Applications I
H. J. Xia, Hefei University of Technology (China)
Y. J. Kim, Korea Advanced Institute of Science and Technology
(Korea, Republic of)
- 6 Sensor Technology and Applications II
W. Sh. Li, Hefei University of Technology (China)
U. H. W. Brand, Physikalisch-Technische Bundesanstalt (Germany)
- 7 On-line Automatic Measurement and Control Vibration, Stress and
Thermal Measurement
Ch. C. Cui, Huaqiao University (China)
D. H. Wang, Chongqing University (China)
- 8 Opto-Electronic Measurement and Image Processing III: Measurement
Signal Analysis & Processing
L. X. Gu, Florida Institute of Technology (United States)
L. L. Wang, Hefei University of Technology (China)
- 9 Precision Theory and Uncertainty Evaluation Quality Engineering
Theory and Technology
L. Q. Zhu, Beijing Information Science and Technology University
(China)
F. Cheng, Agency for Science, Technology and Research, A*STAR,
Huaqiao University (China)

Introduction

Precision is the basis of manufacturing. With the development of science and technology and the improvement of requirements in manufacturing, precision engineering is becoming highly multidisciplinary covering mechanical, electrical, optical, control, and information disciplines. New methods, new technology, and new equipment for measuring are developing faster as well as innovative manufacturing. Micro and nano metrology are becoming practiced, and the requirement of traditional measurements including length, angular, coordination, vibration, and other physics parameters are calling for new technology. With this as the background, we have successfully held eight sessions of the International Symposium on Precision Mechanical Measurement (ISPM). 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 9th ISPM conference was held 18-21 October in Chongqing, China. More than 150 abstracts were submitted to our conference, and more than 160 registered delegates participated in the conference.

