

ACTUATOR 2000

**7th International
Conference on New Actuators
&
International Exhibition
on Smart Actuators and Drive Systems**

**19 - 21 June 2000
Bremen, Germany**

Conference Proceedings

Editor

Hubert Borgmann

Published by

MESSE BREMEN GMBH, Bremen, Germany

© 2000 MESSE BREMEN GMBH, Bremen, Germany

No responsibility is assumed by the publisher for any injury and/or damage to persons or property with regard to products liability, negligence or otherwise, resulting from any use or operation of the methods, products, instructions or ideas contained in the material herein.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means (electronic, mechanical, photocopying) or otherwise, without the prior written permission of the publisher.

Printed in Germany by ASCO-Druck GmbH & Co. KG, Bremen
ISBN-3-933339-02-2

7th International Conference on New Actuators
International Exhibition on Smart Actuators and Drive Systems

ACTUATOR 2000

19 – 21 June, 2000
Bremen Fair and
Congress Center,
Germany

Organised by

MESSE BREMEN GMBH, Bremen, Germany

Endorsements

American Ceramic Society, USA

German Electrical and Electronic Manufacturers' Association (ZVEI)
Division Electronic Components

German Machinery and Plant Manufacturers Association (VDMA)
Fluid Power Transmission and Control Association

Japan Technology Transfer Association

The Society of Non-Traditional Technology, Japan

University of Bremen, Germany

VDI/VDE-Technologiezentrum Informationstechnik GmbH
(VDI/VDE-IT), Germany

Committee

U. Beckord
Dr. Fritz Faulhaber GmbH & Co. KG, Schönaich, Germany

W. Benecke
Universität Bremen, Germany

J. D. Carlson
Lord Corporation, Cary, USA

F. Claeysen
Cedrat Recherche, Meylan, France

T. Gessner
Technische Universität Chemnitz, Germany

E. Quandt
Stiftung caesar, Bonn, Germany

L. M. Schetky
Memry Corporation, Brookfield, USA

B. Schröer
AXON Technologie Consult GmbH, Bremen, Germany

K. Spanner
Physik Instrumente (PI) GmbH & Co., Waldbronn, Germany

J. L. Sproston
The University of Liverpool, United Kingdom

H. D. Stölting
Universität Hannover, Germany

K. Uchino
The Pennsylvania State University, USA

M. Wuttig
University of Maryland, USA

Organiser

H. Borgmann
MESSE BREMEN GMBH, Germany

Welcoming Remarks

Welcome to ACTUATOR 2000 in Bremen. This event continues a series of biennial functions in Bremen and consists of the *7th International Conference on New Actuators* and the *International Exhibition on Smart Actuators and Drive Systems*. Like its predecessors, ACTUATOR 2000 is a major meeting place for leading experts, scientists and managers from all over the world in the field of new actuators. Its main focus is on the transfer of new results from science and research into wide fields of application.

In response to many requests, we are now offering a wide range of application-oriented topics such as nanopositioning, microfluidics, vibration control and medical applications in additional conference sessions. This has been achieved by introducing a parallel track of oral presentations. The schedule has been compiled carefully to avoid time conflicts between related topics. Thus, we will have in total 78 oral presentations and 74 poster contributions this time, all portraying the state of the art and indicating future trends.

Oral sessions will be held in the following fields:

Piezoelectric actuators	Microfluidics
Microactuators	Piezoelectric actuators: applications
Magnetostrictive actuators	Actuators for artificial limbs
Actuators based on ER/MR fluids	Nanopositioning
Shape memory actuators	Vibration control
Electromagnetic actuators	Shape memory actuators: applications
Other actuators	Electromagnetic actuators: linear drives

Some of the sessions will be kicked off by a 30-minute review presented by a member of the Programme Committee, followed by application-oriented presentations of 20 minutes each. The full manuscripts of nearly all the oral papers and poster contributions have been included in these proceedings and, as for 1998, in a separate CD-ROM.

Furthermore, we invite you to also visit the enlarged accompanying trade show with the exhibition forum right in its centre. Here, exhibitors accepted our invitation to give more product-oriented presentations. Thus, conference participants and visitors to the exhibition can inform themselves individually about the current state of actuator technology.

Our special thanks go to all those participants who are actively contributing to this event by sharing the results of their research work here – as authors of papers and posters, or as exhibitors – and thus possibly igniting new projects, initiating new co-operations, or paving the way for new business connections. We also thank the members of the Programme Committee for their excellent work and valuable assistance, and we are particularly grateful to the endorsing institutions and to all others who have supported our public relations work.

We are now looking forward to interesting presentations, lively discussions and helpful new contact, and we would be pleased to welcome you again in two years, for ACTUATOR 2002.

Enjoy your conference!



Rolf Henkhaus
MESSE BREMEN GMBH
General Manager



Hubert Borgmann
MESSE BREMEN GMBH
Organiser ACTUATOR 2000

ACTUATOR 2002

**8th International
Conference on New Actuators
&
2nd International Exhibition
on Smart Actuators and Drive Systems**

**June 2002
Bremen, Germany**

Table of Contents

Oral Contributions	No.	Page
Technology-oriented Sessions		
Piezoelectric Actuators I	A 1.0 - A 1.6	8
Microactuators	A 2.0 - A 2.7	9
Magnetostrictive Actuators	A 3.0 - A 3.5	10
Actuators based on ER/MR Fluids	A 4.0 - A 4.5	11
Shape Memory Actuators I	A 5.0 - A 5.5	12
Low-Power Electromagnetic Actuators I	A 6.0 - A 6.5	13
Other Actuators	A 7.1 - A 7.3	14
Application-oriented Sessions		
Microfluidics	B 1.1 - B 1.6	15
Piezoelectric Actuators II: Applications	B 2.0 - B 2.6	16
Actuators for Artificial Limbs	B 3.1 - B 3.6	17
Nanopositioning	B 4.1 - B 4.5	18
Vibration Control	B 5.1 - B 5.5	19
Shape Memory Actuators II: Applications	B 6.1 - B 6.4	20
Low-Power Electromagnetic Actuators II: Linear Drives	B 7.1 - B 7.4	21
Poster Contributions		
Piezoelectric Actuators	P 1 - P 34	22
Microactuators	P 35 - P 40	26
Magnetostrictive Actuators	P 41 - P 45	27
Actuators Based on ER/MR Fluids	P 46 - P 52	28
Haptic Systems	P 53 - P 55	29
Shape Memory Actuators	P 56 - P 60, P 79	30
Micromanipulation	P 61 - P 64	31
Electromagnetic Actuators	P 65 - P 71	32
Other Actuators	P 72	33
Actuators for Artificial Limbs	P 73 - P 78	33
List of Exhibitors		665
List of Authors		678

A 1 Piezoelectric Actuators I

Technical Papers and Authors	No.	Page
Recent Trend of Piezoelectric Actuator Developments - Material, Design and Drive Technique Related Issues - <i>K. Uchino</i> <i>The Pennsylvania State University, USA</i>	A 1.0	34
Domain Contribution to Dielectric and Piezoelectric Properties of Piezoelectric Ceramics Based on $x \text{Pb}(\text{Zr}, \text{Ti})\text{O}_3 - (1-x) \text{Sr}(\text{K}_{0,25} \text{Nb}_{0,75})\text{O}_3$ (PZT/SKN) Solid Solutions <i>A. Schönecker, P. Obenaus, L. Seffner, U. Keitel,</i> <i>Fraunhofer-IKTS Dresden, Germany</i> <i>T. Scholehwar, Technische Universität Dresden, Germany</i> <i>G. Helke, CeramTec AG, Lauf, Germany</i>	A 1.1	40
Low-Temperature Properties of Piezoelectric Actuators <i>P. Pertsch, H. Marth, Physik Instrumente (PI) GmbH & Co.,</i> <i>Waldbronn, Germany</i> <i>P. Anger, A. Feltz, Omicron Vakuumphysik GmbH,</i> <i>Taunusstein, Germany</i>	A 1.2	41
The Development of a Low Cost, High Performance Piezo Actuator for High Volume Manufacture <i>S. C. Powell</i> <i>PBT Limited, Harlow, United Kingdom</i>	A 1.3	45
Monolithic Piezo-Actuators: Modelling, Validation in the Laboratory and Optimisation of Working Conditions <i>R. Pérez, J.-M. Breguet, H. Bleuler, R. Clavel</i> <i>Swiss Federal Institute of Technology, Lausanne, Switzerland</i>	A 1.4	49
Application of Piezoceramic Multilayer Actuators, Experiences and Solutions <i>R. Bindig, G. Helke</i> <i>CeramTec AG, Lauf, Germany</i>	A 1.5	53
Properties and Reliability of Large PZT Multilayer Stack Actuators <i>K. Lubitz, C. Schuh, T. Steinkopff, A. Wolff</i> <i>Siemens AG, München, Germany</i>	A 1.6	58

A 2 Microactuators

Technical Papers and Authors	No.	Page
Recent Progress of Microactuators <i>T. Gessner</i> <i>Technische Universität Chemnitz, Germany</i>	A 2.0	62
A Spatial Light Modulator Using Moving Liquid Mirrors (MLM) on a CMOS Active-Matrix <i>A. Wolter, K.-U. Kirstein, W. Doleschal, H. Kück, H. Lakner, G. Zimmer</i> <i>Fraunhofer-Institut für Mikroelektronische Schaltungen und Systeme, Dresden, Germany</i>	A 2.1	71
Optical Switch Matrix with Micromechanical Actuator-Arrays <i>R. Loke, J. Sehm, S. Bocklisch</i> <i>Technische Universität Chemnitz, Germany</i>	A 2.2	75
Analysis of Micromachined Electro-Thermal Bent-Beam Actuators and their Applications on Micro-Grippers/Micro-Optics <i>G. B. Lee, H. I. Tsai, C. S. Shey, Y. H. Lin, R. S. Chan, National Cheng Kung University, Tainan, Taiwan</i> <i>C. J. Kung, Far East College, Tainan, Taiwan</i>	A 2.3	79
Micromechanical Scanning Device for Large Vertical Range with High Resolution <i>R. Knöfler, K. Wolf, E. Ahl, U. Kotarsky, W. Manthey, A. Bertz, T. Gessner,</i> <i>Technische Universität Chemnitz, Germany</i> <i>M. Kuchler, Fraunhofer-IZM Berlin/Chemnitz, Germany</i>	A 2.4	83
High Force and Large Displacement Electrostatic Actuators with Curved Electrodes Using Silicon Bulk Micromachining <i>F. Bennini, J. Frühauf, W. Dötzel</i> <i>Technische Universität Chemnitz, Germany</i>	A 2.5	87
Electrostatic Repulsive-Force Microactuators Using Lateral Electrostatic Field Asymmetry <i>K. B. Lee, Samsung Advanced Institute of Technology, Suwon, Rep. of Korea</i> <i>Y.-H. Cho, Korea Advanced Institute of Science and Technology, Taejon, Rep. of Korea</i>	A 2.6	91
Excimer Laser Patterning of Polyimide Microstructure for Permalloy Magnetic Microactuator <i>Y.-S. Lin, C.-T. Pan, S.-C. Chen, J.-J. Jang</i> <i>Industrial Technology Research Institute, Hsinchu, Taiwan</i>	A 2.7	96

A 3 Magnetostrictive Actuators

Technical Papers and Authors	No.	Page
Magnetostrictive Materials and Actuators <i>E. Quandt, Stiftung caesar, Bonn, Germany</i> <i>F. Claeysen, Cedrat Recherche, Meylan, France</i>	A 3.0	100
Large-Stroke Actuators Based on Magnetic-Field-Induced Bending of a Ni-Mn-Ga Element <i>K. Ullakko</i> <i>Helsinki University of Technology, Espoo, Finland</i>	A 3.1	106
Preparation of Films of Fe-45at % PD Magnetic Shape Memory Alloy by Magnetron Sputtering Process and their Characterization <i>H. Yabe, R. Fujii, K. Oguri, H.-H. Uchida, Y. Matsumura, H. Uchida, Y. Nishi</i> <i>Tokai University, Hiratsuka, Kanagawa, Japan</i>	A 3.2	107
Magnetostrictive Galfenol/Alfenol Single Crystal Alloys Under Large Compressive Stresses <i>A. E. Clark, Clark Associates, Adelphi, USA</i> <i>M. Wun-Fogle, J. B. Restorff, Naval Surface Warfare Center, West Bethesda, USA</i> <i>T. A. Lograsso, A. R. Ross, D. L. Schlagel, Ames Laboratory, Ames, USA</i>	A 3.3	111
Magnetostrictive Linear Motor Based on Self-Moving Cell Concept <i>J. Kim, J.-K. Doo, S.-B. Choi</i> <i>Inha University, Incheon, Rep. of Korea</i>	A 3.4	116
Compact Magnetostrictive Actuators and Linear Motors <i>C. H. Joshi</i> <i>Energen, Inc., Billerica, USA</i>	A 3.5	120

A 4 Actuators based on ER/MR Fluids

Technical Papers and Authors	No.	Page
Controllable Fluids in 2000 - Status of ER and MR Fluid Technology <i>J. D. Carlson, Lord Corporation, Cary, USA</i> <i>J. L. Sproston, University of Liverpool, United Kingdom</i>	A 4.0	126
Applications of ER Fluids to Fluid Power Systems (Proposition of Micro ER Valves and Novel Hydraulic Actuators: METERA) <i>Y. Kondoh, S. Yokota</i> <i>Tokyo Institute of Technology, Yokohama, Japan</i>	A 4.1	131
6 kV Power Amplifier Designed for Actuators with Electrorheological (ER) Fluids <i>C. Stiebel, H. Janocha</i> <i>Universität des Saarlandes, Saarbrücken, Germany</i>	A 4.2	135
Semi-Active Control of a Vehicle Suspension System Using MR Damper <i>G. Z. Yao, F. F. Yap, W. H. Li, G. Chen, S. H. Yeo, Y. C. Guo</i> <i>Nanyang Technological University, Singapore</i>	A 4.3	139
Modeling of a Magnetorheological Damper by Parameter-Estimation <i>P. Lederer, Quillion Ltd., Cambridge, United Kingdom</i> <i>M. G. Salloker, Technikum Joanneum GmbH, Kapfenberg, Austria</i> <i>S. Doczy, University of Technology, Graz, Austria</i>	A 4.4	143
Development of Damper for New Electronically Controlled Power Steering System by Magneto-Rheological Fluid <i>Y. Park, B. Jung</i> <i>Korea Advanced Institute of Science and Technology, Taejon, Rep. of Korea</i>	A 4.5	147

A 5 Shape Memory Actuators

Technical Papers and Authors	No.	Page
Shape Memory Actuators in MEMS and Medicine <i>M. Wuttig, University of Maryland, USA</i> <i>L. McD. Schetky, Memry Corporation, Brookfield, USA</i>	A 5.0	151
Time Response of Ni-Ti Actuator Wire <i>P. L. Potapov, Antwerp University, Belgium</i> <i>E. P. da Silva, Technische Universität Berlin, Germany</i>	A 5.1	156
Laser Material Processing of Shape Memory Alloys <i>H. Haferkamp, S. Paschko, F. von Alvensleben, M. Goede</i> <i>Laser Zentrum Hannover e.V., Germany</i>	A 5.3	163
A New Production Method of SMA Micro Actuator by Sputtering TiNi and Using Ni Mold <i>K. Kuribayashi, T. Yasumune</i> <i>Yamaguchi University, Ube, Japan</i>	A 5.4	167
Thin Ti(Ni, Cu) Film Composites <i>B. Winzek, E. Quandt, Stiftung caesar, Bonn, Germany</i> <i>H. Holleck, Forschungszentrum Karlsruhe GmbH, Germany</i>	A 5.5	172

A 6 Low-Power Electromagnetic Actuators I

Technical Papers and Authors	No.	Page
Small Electromagnetic Disk Drives <i>H.-D. Stölting</i> <i>Universität Hannover, Germany</i>	A 6.0	177
3-Phase Coil for Planar Brushless Micromotor <i>P.-A. Gilles, O. Cugat, J. Delamare, V. Fernandez,</i> <i>Laboratoire d'Electrotechnique de Grenoble, France</i> <i>C. Divoux, Laboratoire d'Electronique, de</i> <i>Technologie et d'Instrumentation, Grenoble, France</i>	A 6.1	181
Pancake Shaped Micro Gear System with High Transmission Ratio <i>R. Degen, W. Ehrfeld, F. Michel</i> <i>Institut für Mikrotechnik Mainz GmbH, Germany</i>	A 6.2	185
An Induction Micromotor on a Permanent Magnet Bearing <i>V. Fernandez, O. Cugat, G. Reyne, P.-A. Gilles,</i> <i>Laboratoire d'Electrotechnique de Grenoble, France</i> <i>S. Basrour, Laboratoire de Physique et de Métrologie des</i> <i>Oscillateurs, Besançon, France</i>	A 6.3	189
Penny-Motor: A Family of Novel Ultraflat Electromagnetic Micromotors <i>S. Kleen, W. Ehrfeld, F. Michel, M. Nienhaus,</i> <i>Institut für Mikrotechnik Mainz GmbH, Germany</i> <i>H.-D. Stölting, Universität Hannover, Germany</i>	A 6.4	193
New Concept of a Spherical Actuator with Three Degrees of Freedom <i>K. Kahlen, R. W. De Doncker</i> <i>RWTH Aachen, Germany</i>	A 6.5	197

A 7 Other Actuators

Technical Papers and Authors	No.	Page
Electroactive Polymers as Artificial Muscles Changing Robotics Paradigms <i>Y. Bar-Cohen, S. Leary</i> <i>Jet Propulsion Laboratory/Caltech, Pasadena, USA</i>	A 7.1	201
Actuators from Carbon Nanotubes <i>S. Roth, A. Minett, Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany</i> <i>R. Baughman, Allied Signal Inc., Morristown, USA</i> <i>O. Jaschinski, Université de Montpellier, France</i>	A 7.2	205
ZrNi Thin Films for Fast Reversible Hydrogen Pressure Actuation <i>J. G. E. Gardeniers, J. F. Burger, H. van Egmond, H. J. Holland, H. J. M. ter Brake, M. Elwenspoek</i> <i>University of Twente, Enschede, The Netherlands</i>	A 7.3	208

B 1 Microfluidics

Technical Papers and Authors	No.	Page
Time Response of Shape Memory Microvalves <i>M. Kohl, I. Hürst, B. Krevet</i> <i>Forschungszentrum Karlsruhe GmbH, Germany</i>	B 1.1	212
An Intrinsically Safe Optically Powered Hydraulic Valve <i>J. Lim, Q. P. Yang, K. F. Hale, B. E. Jones,</i> <i>Brunel University, Uxbridge, Middlesex, United Kingdom</i> <i>P. R. Jackson, Flight Refuelling Ltd., Dorset, United Kingdom</i>	B 1.2	216
Micromachined 3/2 Port Pressure Controlling Valve <i>H. J. Quenzer, B. Wagner,</i> <i>Fraunhofer-Institut für Siliziumtechnologie, Itzehoe, Germany</i> <i>G. Günther, RWTH Aachen, Germany</i>	B 1.3	220
Pneumatic Silicon Microvalves with Piezoelectric Actuation <i>M. Weinmann, P. Post, H. Vollmer,</i> <i>FESTO AG & Co., Esslingen, Germany</i> <i>R. Wanner, Beurer GmbH & Co., Ulm, Germany</i> <i>S. Kluge, P. Woias, Fraunhofer-Institut für Mikroelektronische Schaltungen und Systeme, München, Germany</i>	B 1.4	224
An Actuation Coupling System for a Fast and Low-Volume Micropipetting Device with Integrated Sensors <i>N. Szita, J. Dual,</i> <i>Eidgenössische Technische Hochschule Zürich, Switzerland</i> <i>R. Buser, Institute of Microsystems, Buchs SG, Switzerland</i>	B 1.5	228
A Micro-Droplet Dispenser Based on a Shock Principle <i>M. Moreau, Y. Fouillet, B. Diem</i> <i>Laboratoire d'Electronique, de Technologie et d'Instrumentation, Grenoble, France</i>	B 1.6	232

B 2 Piezoelectric Actuators II: Applications

Technical Papers and Authors	No.	Page
Breakthrough in Piezo Actuator Applications <i>K. Spanner</i> <i>Physik Instrumente (PI) GmbH & Co., Waldbronn, Germany</i>	B 2.0	236
A Miniature Piezoelectric Rotary Motor Using Two Orthogonal Bending Modes of a Hollow Cylinder <i>B. Koc, K. Uchino,</i> <i>The Pennsylvania State University, USA</i> <i>J. F. Tressler, Naval Research Laboratory, Washington, USA</i>	B 2.1	242
Gyro-Moment Motor <i>K. Kanauchi, Y. Tomikawa</i> <i>Yamagata University, Yonezawa, Japan</i>	B 2.2	246
Piezoelectric Linear Motors <i>T. Hemsel, J. Wallaschek</i> <i>Universität Paderborn, Germany</i>	B 2.3	250
Actuators with Piezoelectric Impact Drives <i>K. Bartzke, S. Mack, Carl Zeiss Jena GmbH, Germany</i> <i>M. Burkhardt, P. Dittrich, Fachhochschule Jena, Germany</i> <i>E. Hennig, PI Ceramic GmbH, Lederhose, Germany</i>	B 2.4	254
Distributed Actuator Systems Based on Piezoceramics <i>B. Z. Janos, N. W. Hagood</i> <i>Massachusetts Institute of Technology, Cambridge, USA</i>	B 2.5	258
Versatile Ultrasonic Piezo Drive for Direct-Drive Motorization <i>F. Claeysen, R. Le Letty, M. F. Six, M. Debarnot, N. Lhermet,</i> <i>Cedrat Recherche, Meylan, France</i> <i>M. Privat, CNES, Toulouse, France</i>	B 2.6	262

B 3 Actuators for Artificial Limbs

Technical Papers and Authors	No.	Page
Application of a Hydraulic Bilateral Servo Actuator for a Patient Supporting Robot <i>Y. Saito, K. Ohnishi, Y. Sunagawa,</i> <i>Tokyo Denki University, Hiki, Saitama, Japan</i> <i>S. Ishigami, National Defense Medical College, Tokorozawa,</i> <i>Saitama, Japan</i> <i>S. Taguchi, Nihon Shinkan Co., Ltd., Shirakawa, Fukushima,</i> <i>Japan</i>	B 3.1	266
A Micro Rubber Artificial Muscle Driven by a Micro Compressor for Artificial Limbs <i>Y. K. Lee, I. Shimoyama</i> <i>The University of Tokyo, Japan</i>	B 3.2	272
An Actuator System for a Novel Biomechatronic Prosthetic Hand <i>M. C. Carrozza, P. Dario, R. Lazzarini, B. Massa, M. Zecca,</i> <i>S. Roccella, Centro INAIL/IRTR, Viareggio and</i> <i>Scuola Superiore Sant'Anna, Pisa, Italy</i> <i>R. Sacchetti, Centro Protesi INAIL, Vigorso di Budrio, Italy</i>	B 3.3	276
Development of a Shape Memory Alloy Actuated Hand <i>K. J. DeLaurentis, C. Mavroidis,</i> <i>The State University of New Jersey, USA</i> <i>C. Pfeiffer, CyBotic Technologies, Inc., New Jersey, USA</i>	B 3.4	281
High Torque Ultrasonic Motors for Hand Prosthetics: Current Status and Trends <i>J. L. Pons, H. Rodríguez, A. Duarte, A. R. Jiménez, R. Ceres,</i> <i>Consejo Superior de Investigaciones Científicas, Madrid, Spain</i> <i>I. Luyckx, D. Reynaerts, H. Van Brussel,</i> <i>Katholieke Universiteit Leuven, Belgium</i>	B 3.5	285
Muscle-Like Pneumatic Actuators for Below-Knee Prostheses <i>G. K. Klute, J. M. Czerniecki,</i> <i>Dept. of Veterans Affairs, and University of Washington,</i> <i>Seattle, USA</i> <i>B. Hannaford, University of Washington, Seattle, USA</i>	B 3.6	289

B 4 Nanopositioning

Technical Papers and Authors	No.	Page
Hexapod Parallel Kinematics with Sub-Micrometer Accuracy <i>R. GlöB</i> <i>Physik Instrumente (PI) GmbH & Co., Waldbronn, Germany</i>	B 4.1	293
Piezoelectric X-Y-Micropositioner Made of Photosensitive Glass to Form one Micro-Handling Unit <i>R. Keoschkerjan, F. Qiao, C. Schilling, H. Wurmus,</i> <i>Technische Universität Ilmenau, Germany</i> <i>M. Harutyunyan, State Engineering University of Armenia,</i> <i>Erevan, Armenia</i>	B 4.2	296
A Rigid and Accurate XYZ Positioning System Based on a Piezo-Electric Stepper Drive <i>M. Versteheyhe, D. Reynaerts, F. Al-Bender, H. Van Brussel</i> <i>Katholieke Universiteit Leuven, Belgium</i>	B 4.3	300
Detection and Compensation of Misalignments in Ground- and Space Based Interferometers Realised by Optical Sensors and Piezoelectric Actuators <i>U. Schnars, K. Sommer, OHB-System, Bremen, Germany</i> <i>V. Kebbel, H.-J. Hartmann, W. Jüptner, BIAS, Bremen, Germany</i>	B 4.4	304
Different Methods of Signal Preshaping for Highly Dynamic Piezo Positioning Systems <i>R. GlöB</i> <i>Physik Instrumente (PI) GmbH & Co., Waldbronn, Germany</i>	B 4.5	308

B 5 Vibration Control

Technical Papers and Authors	No.	Page
Designing a Magnetostrictive Actuator by Using Simple Predictive Tools and Experimental Data <i>E. Monaco, F. Franco, L. Lecce</i> <i>Università di Napoli, Italy</i>	B 5.1	312
Design, Manufacturing and Experimental Evaluation of a Magnetostrictive Actuator for Active Vibration Control and Damage Analysis <i>F. Stillesjö, G. Engdahl,</i> <i>Royal Institute of Technology, Stockholm, Sweden</i> <i>C. May, H. Janocha,</i> <i>Universität des Saarlandes, Saarbrücken, Germany</i>	B 5.2	318
Vibration Damping with a Piezoelectric Torque Drive <i>F. Palis, U. Ladra, A. Schwarzkopf</i> <i>Otto-von-Guericke-Universität Magdeburg, Germany</i>	B 5.3	322
Electromagnetic Actuators for Active Engine Vibration Cancellation <i>C. Hartwig, H. Haase, Universität Hannover, Germany</i> <i>M. Hofmann, H.-J. Karkosch,</i> <i>ContiTech Vibration Control GmbH, Hannover, Germany</i>	B 5.4	326
Development of a Novel Piezoelectric Inertial Absorber <i>H. Du, Y. J. Tang, S. F. Ling</i> <i>Nanyang Technological University, Singapore</i>	B 5.5	330

B 6 Shape Memory Actuators II: Applications

Technical Papers and Authors	No.	Page
A New SMA Actuated Miniature Silicon Gripper for Micro Assembly <i>S. Bütetfisch, G. Pokar, S. Büttgenbach, J. Hesselbach</i> <i>Technische Universität Braunschweig, Germany</i>	B 6.1	334
Shape Memory Alloy Based Micro Actuators <i>V. Galhotra, V. Gupta, V. Martynov, A. D. Johnson</i> <i>TiNi Alloy Company, San Leandro, USA</i>	B 6.2	338
Cu-Zn-Al SMA Actuators for Active Disassembly Using Smart Materials (ADSM) <i>J. D. Chiodo, M. Perkins, E. H. Billett, D. J. Harrison,</i> <i>Brunel University, Egham, Surrey, United Kingdom</i> <i>A. W. Anson, Anson Medical LTD., Oxfordshire, United Kingdom</i>	B 6.3	342
Development of a New Micro Gas Valve Composed of a SMA Thin Film and Micro Distance Sensor <i>X. Ding, K. Kuribayashi, T. Hashida</i> <i>Yamaguchi University, Ube, Japan</i>	B 6.4	346

B 7 Low-Power Electromagnetic Actuators II: Linear Drives

Technical Papers and Authors	No.	Page
Contribution to Short Stroke Linear DC Motors with Permanent Magnets <i>R. Hanitsch, R. Okonkwo</i> <i>Technische Universität Berlin, Germany</i>	B 7.1	351
Electromagnetic Microactuators for Optical Applications <i>Th. Kunz, P. Krippner, A. Fath, M. Scherr, J. Mohr</i> <i>Forschungszentrum Karlsruhe GmbH, Germany</i>	B 7.2	355
Application of Electrodynamic Planar Drives <i>E. Saffert, E. Kallenbach,</i> <i>Technische Universität Ilmenau, Germany</i> <i>S. Pause, LLT Laser- und Lichtstrahl-Technologie GmbH,</i> <i>Ilmenau, Germany</i>	B 7.3	359
A Novel Variable Reluctance Micromotor for Linear Actuation <i>H. H. Gatzen, H.-D. Stölting, Universität Hannover, Germany</i> <i>S. Büttgenbach, Technische Universität Braunschweig, Germany</i> <i>H. Dimigen, Fraunhofer-Institut für Schicht- und</i> <i>Oberflächentechnik, Braunschweig, Germany</i>	B 7.4	363

Poster Contributions: Piezoelectric Actuators

Technical Papers and Authors	No.	Page
Control for Ultrasonic Motors with LLCC-Resonant Converter <i>T. Schulte, H. Grotstollen, N. Fröhleke</i> <i>Universität-Gesamthochschule Paderborn, Germany</i>	P 1	367
Piezoelectric Rotary-Linear-Actuators for Miniaturised or Micro Parallel Robots <i>Y. Zhang, J. Hesselbach</i> <i>Technische Universität Braunschweig, Germany</i>	P 2	371
Robotic Wrist Actuator with High Torque Piezoelectric Travelling-Wave-Motor <i>M. Schreiner, W. Huber, H.-P. Schöner,</i> <i>DaimlerChrysler AG, Frankfurt, Germany</i> <i>M. Dörmer, DaimlerChrysler Aerospace, Bremen, Germany</i>	P 3	375
Motor Characteristics of Piezoelectric Micropush Motors for Rotating Systems <i>G. Diefenbach, C. Reichinger</i> <i>Philips GmbH Forschungslaboratorien, Aachen, Germany</i>	P 4	379
Global Performance Evaluation of TWUM's Drivers <i>A. Duarte, H. Rodríguez, A. R. Jiménez, J. L. Pons, R. Ceres</i> <i>Consejo Superior de Investigaciones Científicas, Madrid, Spain</i>	P 5	383
Piezoelectric Actuator with Integrated Sensor for Microgripper Made of Glass <i>F. Qiao, H. Wurmus</i> <i>Technische Universität Ilmenau, Germany</i>	P 6	387
Linear Quasi-Traveling Wave Ultrasonic Motor <i>J. Scortesse, S. Biwersi, J. F. Manceau, F. Bastien</i> <i>Laboratoire de Physique et de Métrologie des Oscillateurs,</i> <i>Besançon, France</i>	P 7	391
A Smart Actuator to Transonic Wave Drag Reduction <i>C. Esposito, A. Concilio,</i> <i>The Italian Aerospace Research Centre, Capua, Italy</i> <i>S. Ameduri, L. Lecce, University of Naples, Italy</i>	P 8	395

Piezoelectric Actuators

Technical Papers and Authors	No.	Page
Multi-Degrees-of-Freedom Ultrasonic Actuator Employing Multi-Vibration Modes of a Disk <i>M. Aoyagi, T. Ogasawara, Y. Tomikawa, Yamagata University, Yonezawa, Japan T. Takano, Tohoku Institute of Technology, Sendai, Japan</i>	P 9	399
High-Speed Real Time Measurement System of High-Power Piezoelectric Characteristics <i>S. Hirose, M. Matsumoto, Y. Tomikawa, Yamagata University, Yonezawa, Japan T. Takano, Tohoku Institute of Technology, Sendai, Japan</i>	P 10	403
Analytical Simulation of the Contact Process for a Coupled-Resonance Piezoelectric Motor (CRP) <i>A. Lewalter, G. Diefenbach, C. Reichinger Philips GmbH Forschungslaboratorien, Aachen, Germany</i>	P 12	407
Concept for Optimised Force Transmission in Travelling Wave Type Ultrasonic Motors <i>J. Maas DaimlerChrysler AG, Frankfurt, Germany</i>	P 13	411
Investigations of the Loss Power of Stacked Actuators <i>D. Rößger, E. Hennig PI Ceramic GmbH, Lederhose, Germany</i>	P 14	415
Performance of Piezoelectric Ceramic Multilayer Components Based on Hard and Soft PZT <i>B. Andersen, E. Ringgaard, T. Bove, Ferroperm Piezoceramics A/S, Kvistgård, Denmark A. Albareda, R. Pérez, Universitat Politècnica de Catalunya, Spain</i>	P 15	419
Static and Dynamic Performance of Stacked Multilayer Actuators Based on Hard and Soft PZT <i>B. Andersen, E. Ringgaard, Ferroperm Piezoceramics A/S, Kvistgård, Denmark L. S. Nielsen, PZTech ApS, Hellebæk, Denmark</i>	P 16	423

Piezoelectric Actuators

Technical Papers and Authors	No.	Page
Piezoelectric Driven Press for Production of Metallic Microparts by Forming <i>A. Hess</i> <i>Zentrum für Fertigungstechnik Stuttgart, Germany</i>	P 17	427
Development of a Flexible Piezoelectric Micro-Robot for the Handling of Micro-Objects <i>S. Fahlbusch, S. Fatikow, J. Seyfried,</i> <i>Universität Karlsruhe (TH), Germany</i> <i>T. Doll, Intelligente Peripherien für Roboter GmbH,</i> <i>Schwaigern, Germany</i> <i>W. Kammrath, K. Weiss,</i> <i>Kammrath & Weiss GmbH, Dortmund, Germany</i>	P 18	431
A Note on Minimization of Electrical Losses in Controllers of Piezoelectric Motors <i>M. Berg, P. Hagedorn</i> <i>Technische Universität Darmstadt, Germany</i>	P 19	435
Charge Controlled Power Amplifier for High-Dynamic Piezoelectrical Drives <i>R. Kasper, A. Wagner, J. Schröder, W. Heinemann</i> <i>Otto-von-Guericke-Universität Magdeburg, Germany</i>	P 20	439
Characterization of Piezoelectric Multilayer Actuators: Low- and High Field Behavior <i>H.-J. Schreiner, R. Bindig, K. Tzschentke, G. Helke</i> <i>CeramTec AG, Lauf, Germany</i>	P 22	443
Design and Construction of a Linear Piezo-Electrically Driven Forced Travelling Wave Motor <i>B. Houben, W. Symens, M. Versteijhe, D. Reynaerts, H. Van Brussel</i> <i>Katholieke Universiteit Leuven, Belgium</i>	P 23	447
The Inchworm® Piezoelectric Stepping Motor - Advances in Design, Performance and Applications <i>D. Henderson, J. Fasick</i> <i>Burleigh Instruments Inc., Fishers, USA</i>	P 24	451

Piezoelectric Actuators

Technical Papers and Authors	No.	Page
Mechanisms Based on Piezo Actuators <i>F. Claeysen, R. Le Letty, F. Barillot, N. Lhermet, H. Fabbro, Cedrat Recherche, Meylan, France P. Guay, CNES, Toulouse, France M. Yorck, SI IKOSS B.V., Leiden, The Netherlands</i>	P 25	456
A New Method for the Calculation of Stresses and Reliability in Multilayer Electrostrictive Actuators <i>M. Koyuncu, Starlab Research nv/rsa, Brussels, Belgium W. B. Carlson, S. M. Pilgrim, Alfred University, NY, USA</i>	P 26	460
Bistable Mechanism Actuated by Piezoelectrics <i>G. Bertolotto Bianc, F. Colombo, P. Mandurino, A. Sciacca ABB Ricerca S.p.A., Sesto S. Giovanni, Italy</i>	P 27	464
Novel Digital Control Algorithm Improves Dynamic Performance of Piezo-NanoScanners by Several 100 Times <i>X. Zhao Physik Instrumente (PI) GmbH & Co., Waldbronn, Germany</i>	P29	468
Precise Positioning Piezoelectric Actuator: A New Concept Based on the Coupling of Travelling Waves <i>B. Nogarède, V. Monturet Laboratoire d'Electrotechnique et d'Electronique Industrielle, Toulouse, France</i>	P 30	471
Reduced Temperature Sensitivity of Low-Voltage Oscillating Piezo Chopper <i>P. Drögmöller, J. Sorber, G. Gerlach, Technische Universität Dresden, Germany P. Bücken, piezosystem jena, Germany</i>	P 32	475
A New Piezo Spindle Drive Combines Microstep Movement and Continuous Motion <i>U. Hahn, W. Wischnewskyi, R. Glöß Physik Instrumente (PI) GmbH & Co., Waldbronn, Germany</i>	P 33	479
Actuators and Actuator Systems for Oscillation-Supported Metal Forming as Components for Metal-Forming Machines <i>K.-H. Wurst, M. Conrath, C. Liu Universität Stuttgart, Germany</i>	P 34	482

Microactuators

Technical Papers and Authors	No.	Page
A 3-Dimensional Actuator Based on a Novel Combination of Thermally Actuated Planar and Vertical Bimorphs <i>H. Sehr, A. G. R. Evans, A. Brunnschweiler, G. J. Ensell, M. Kraft</i> <i>University of Southampton, United Kingdom</i>	P 35	486
Optimization of Electro-Mechanical Interactions in Sensor and Actuator Design <i>H.-P. Lien</i> <i>ISE Integrated Systems Engineering AG, Zürich, Switzerland</i>	P 36	490
Novel Parametric-Effect MEMS Amplifiers/Transducers <i>J.-P. Raskin, Université Catholique de Louvain, Louvain-la-Neuve, Belgium</i> <i>B. T. Khuri-Yakub, Stanford University, USA</i> <i>G. M. Rebeiz, University of Michigan, USA</i>	P 37	494
Optimal Shape Design of Curved Electrodes for a Rotary Microactuator <i>S. Jung, J. Jeon, Y. E. Pak, S. Lee</i> <i>Samsung Advanced Institute of Technology, Suwon, Rep. of Korea</i>	P 38	498
A Thermally Buckling Microvalve <i>M.-J. Tsai, L.-H. Lo, T.-H. Tsai, C.-H. Fan, C.-L. Wu</i> <i>MEMS Research Div. MIRL/ITRI, Chutung, Hsinchu, Taiwan</i>	P 39	502
Sub-nl Flow Measurement Method for Microfluidic Actuators <i>M. Wackerle, M. Richter, P. Woias, F. Goldschmidtboing</i> <i>Fraunhofer-Institut für Mikroelektronische Schaltungen und Systeme, München, Germany</i>	P 40	507

Magnetostrictive Actuators

Technical Papers and Authors	No.	Page
Effect of Plasma Processes on Magnetostriction of Tb-Fe Thin Films <i>H. Uchida, Y. Matsumura, M. Wada, M. Ono, K. Nakazato, H.-H. Uchida</i> <i>Tokai University, Hiratsuka, Kanagawa, Japan</i>	P 41	511
Design and Simulation of Magnetic Shape Memory and Magnetostrictive Actuators <i>Z. G. Wei, G. Engdahl</i> <i>Royal Institute of Technology, Stockholm, Sweden</i>	P 42	515
Linear Controllers for Magnetostrictive Actuators <i>M. G. Salloker, G. FraiB, A. Hartberger, R. Krappinger, G. Mang</i> <i>Technikum Joanneum GmbH, Kapfenberg, Austria</i>	P 43	519
Parameter-Identification for Linear Models of Magnetostrictive Actuators <i>M. G. Salloker, G. FraiB, A. Hartberger, R. Krappinger, G. Mang</i> <i>Technikum Joanneum GmbH, Kapfenberg, Austria</i>	P 44	523
Magnetic Shape Memory (MSM) Actuators <i>I. Aaltio, K. Ullakko</i> <i>AdaptaMat Ltd., Espoo, Finland</i>	P 45	527

Actuators Based on ER/MR Fluids

Technical Papers and Authors	No.	Page
Smart Material Actuators for Information Storage Devices <i>S. B. Choi, S. C. Lim, J. S. Park</i> <i>Inha University, Incheon, Rep. of Korea</i>	P 46	531
Control Characteristics of ER/MR Fluid-Based Actuators for Automotive Applications <i>S. B. Choi, C. C. Cheong, H. S. Lee, H. J. Song</i> <i>Inha University, Incheon, Rep. of Korea</i>	P 47	535
High Dynamic Electrorheological Actuators: Applications - Testing Machines and Adaptronic Transport Systems <i>H. Rosenfeldt, L. Johnston,</i> <i>Schenck Pegasus GmbH, Darmstadt, Germany</i> <i>G. Fees, RWTH Aachen, Germany</i>	P 48	539
Force-Feedback Device using Magnetorheological Fluid: MR CLUTCH <i>Y. Park, B. Jung</i> <i>Korea Advanced Institute of Science and Technology,</i> <i>Taejon, Rep. of Korea</i>	P 49	543
A Comparison Between Electrorheological and Magnetorheological Fluids Subjected to Impulsive Loads <i>A. K. El Wahed, J. L. Sproston</i> <i>University of Liverpool, United Kingdom</i>	P 50	547
Nonlinear Robot Control System Including Controllable Passive Element Using Magneto-Rheological Suspension <i>T. Saito, Tokyo Engineering University, Japan</i> <i>N. Sugimoto, H. Ikeda,</i> <i>National Institute of Industrial Safety, Tokyo, Japan</i>	P 51	551
Transitional and Solid State Behaviour of a Magnetorheological Clutch <i>D. Lampe, R. Grundmann</i> <i>Technische Universität Dresden, Germany</i>	P 52	555

Haptic Systems

Technical Papers and Authors	No.	Page
Application of Magnetorheological Fluids in Programmable Haptic Knobs <i>B. Ackermann, R. Elferich</i> <i>Philips GmbH Forschungslaboratorien, Aachen, Germany</i>	P 53	559
Haptic System Based on an Electrorheological Fluid <i>H. Böse, H.-J. Berkemeier, A. Trendler</i> <i>Fraunhofer-Institut für Silicatforschung, Würzburg, Germany</i>	P 54	563
Micro-Actuation Principles for High-Resolution Graphic Tactile Displays <i>W. Brenner, S. Mitic, A. Vujanic, G. Popovic</i> <i>Technische Universität Wien, Austria</i>	P 55	567

Shape Memory Actuators

Technical Papers and Authors	No.	Page
Engineering Calculation Methods of SM Element Deformations <i>L. Stupelis, Institute of Mathematics and Informatics, Vilnius, Lithuania</i> <i>E. Kibirkštis, R. Liaudinskas, A. Dabkevicius, Kaunas University of Technology, Lithuania</i>	P 56	571
Designing Microgrippers for Shape Memory Actuators <i>R. Salim, Hewlett-Packard GmbH, Bad Homburg, Germany</i> <i>S. Schwuchow, JET Consulting GmbH & Co. KG, Bad Homburg, Germany</i>	P 57	576
A Highly Flexible and Adaptive Micromechanical Actuator System - Potential of Application <i>C. Abel-Keilhack, J. Hesselbach, M. Leester-Schädel, S. Büttgenbach, Technische Universität Braunschweig, Germany</i>	P 58	579
Shape Memory Actuator for Automotive Applications <i>S. Alacqua, G. Alessandretti, F. Butera</i> <i>Centro Ricerche Fiat, Orbassano, Italy</i>	P 59	583
Shape Adaption of Fixed Wing Aircraft by Shape Memory Alloys (SMA) <i>G. Pritschow, W. Wadehn, G. Kehl</i> <i>Universität Stuttgart, Germany</i>	P 60	587
Fabrication of Ti-Ni Alloy Foils by Ultrafine Laminates Method <i>K. Tsuchiya, N. Yusop Binti, M. Umemoto, Toyohashi University of Technology, Japan</i> <i>M. Sasaki, D. Imai, Nippon Metal Industry, Co., Ltd., Sagamihara, Japan</i>	P 79	662

Micromanipulation

Technical Papers and Authors	No.	Page
Actuators for Modulation of Brownian Mobility of Micro-Objects <i>S. Dadunashvili</i> <i>Georgian Technical University, Tbilisi, Georgia</i>	P 61	591
A Novel Micro Manipulating System and its Application in Micro Assembly <i>L. Ning Sun, T. Zhang, W. Bin Rong, X. Jun Deng, H. gao Cai</i> <i>Harbin Institute of Technology, P. R. China</i>	P 62	595
Research on Micromanipulating Arm Integrated with Displacement Sensors <i>T. Zhang, L. Ning Sun, Z. Jie Li, H. gao Cai</i> <i>Harbin Institute of Technology, P. R. China</i>	P 63	599
Design of Miniature Manipulators for Integration in a Self-Propelling Endoscope <i>J. Peirs, D. Reynaerts, H. Van Brussel</i> <i>Katholieke Universiteit Leuven, Belgium</i>	P 64	603

Electromagnetic Actuators

Technical Papers and Authors	No.	Page
Reactionless, Momentum Compensated Resonant Linear Drive <i>S. Kovalev, R. Glöß</i> <i>Physik Instrumente (PI) GmbH & Co., Waldbronn, Germany</i>	P 65	607
Permanent Magnetic Polymer-Bonded Material Basing on NdFeB and their Application in Mini and Micro Actuators <i>E. Kallenbach, V. Zöppig, H. Kube,</i> <i>Technische Universität Ilmenau, Germany</i> <i>F. Beyer, R. Hermann,</i> <i>Steinbeis-Stiftung für Wirtschaftsförderung, Ilmenau, Germany</i> <i>B. Pawlowski, J. Töpfer,</i> <i>inocermic GmbH, Hermsdorf, Germany</i> <i>H. Töpfer, Bürkert GmbH & Co. KG, Großröhrsdorf, Germany</i>	P 66	611
Optimal Application Fields for Electromagnetic and Piezoceramic Actuators <i>J. Heinrich, R. Hermann, E. Kallenbach,</i> <i>Steinbeis-Stiftung für Wirtschaftsförderung, Ilmenau, Germany</i> <i>M. Eccarius, Technische Universität Ilmenau, Germany</i>	P 67	615
Control of Drives in a Nonlinear Two-Mass System <i>I. Schöling, B. Orlik</i> <i>Universität Bremen, Germany</i>	P 68	619
Integrated Drive with a New High Dynamic State Control for a Mains Side Actuator <i>H. Raffel, B. Orlik</i> <i>Universität Bremen, Germany</i>	P 69	623
DVR: A High-Performance 22.5 GB Optical Disk Drive with High Numerical Aperture Objective Lens <i>P. J. C. H. Smulders, J. W. Aarts, J. P. Baartman, B. H. W. Hendriks</i> <i>Philips Research Laboratories, Eindhoven, The Netherlands</i>	P 70	627
A New Type Single-Phase Stepping Motor <i>Y. Qing, Q. JianFei</i> <i>Southwest Institute of Electronic Engineering,</i> <i>Sichuan, P. R. China</i>	P 71	631

Other Actuators

Technical Papers and Authors	No.	Page
Conducting Polymer Materials and their Mechanical Properties for Actuation: The Case of Polypyrrole <i>M. Benslimane, P. Gravesen, Danfoss AIS, Nordborg, Denmark K. West, L. Bay, S. Skaarup, The Technical University of Denmark, Lyngby, Denmark</i>	P 72	635

Actuators for Artificial Limbs

Stiffness Controlled Voice Coil Actuator for Musculoskeletal Studies <i>E. Gallasch, H. P. Taferner, M. Fend, B. Wronski, Physiologisches Institut der Universität Graz, Austria D. Rafolt, Institut für Biomedizinische Technik und Physik, AKH Wien, Austria</i>	P 73	639
Actuators for Upper Limb Prosthetics: The Experience of the Manus Project <i>I. Luyckx, D. Reynaerts, H. Van Brussel, Katholieke Universiteit Leuven, Belgium H. Rodríguez, J. L. Pons, R. Ceres, Consejo Superior de Investigaciones Científicas, Madrid, Spain</i>	P 74	643
Research on a Functional Anthropotic Hand for Electric Prosthetic Hand <i>K. Ohnishi, Y. Saito Tokyo Denki University, Hiki, Saitama, Japan</i>	P 75	647
A New Design for a Hybrid Prosthetic Elbow Motor <i>C. Pfeiffer, CyBotic Technologies, Inc., New Jersey, USA C. Mavroidis, The State University of New Jersey, USA</i>	P 76	653
Comparison of Actuators for Prosthetic Finger Control <i>J. A. Flint, W. Craelius The State University of New Jersey, USA</i>	P 77	654
Biomimetic Systems for Limb Prosthetics Using Pneumatic Muscle Actuators <i>D. G. Caldwell, N. Tsagarakis University of Salford, Manchester, United Kingdom</i>	P 78	658