

2023 IEEE World Haptics Conference (WHC 2023)

**Delft, Netherlands
10-13 July 2023**



**IEEE Catalog Number: CFP23365-POD
ISBN: 979-8-3503-9994-3**

**Copyright © 2023 by the Institute of Electrical and Electronics Engineers, Inc.
All Rights Reserved**

Copyright and Reprint Permissions: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

****** This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP23365-POD
ISBN (Print-On-Demand):	979-8-3503-9994-3
ISBN (Online):	979-8-3503-9993-6
ISSN:	2835-9518

Additional Copies of This Publication Are Available From:

Curran Associates, Inc
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: (845) 758-0400
Fax: (845) 758-2633
E-mail: curran@proceedings.com
Web: www.proceedings.com

Contents

Frontmatter

Message from the Conference Co-Chairs	iii
Message from the Conference Editorial Board	v
Organization Committee	vi
Program Committee	viii
Associate Editors and Reviewers	ix
Sponsors	xii
Leaflet IEEE Haptics Symposium 2024	xiv
Leaflet EUROHAPTICS 2024	xv
Leaflet AsiaHaptics 2024	xvi

Oral Session 1A Perception 1

Perception of and Response to a Haptic Device as a Function of Signal Complexity Antonio Alvarez Valdivia and Laura H. Blumenschein — <i>Purdue University, USA</i>	1
The Tactile Distance Aftereffect Transfers to Roughness Perception Michaela Jeschke, Knut Drewing, and Elena Azañón — <i>Justus-Liebig University, Germany; Otto-von-Guericke University, Germany; Leibniz Institute for Neurobiology, Germany</i>	8
Eyes-Free Fingertip Guidance Based on Tactile Cues, an Extension of the Steering Law Quentin Agobert, Corentin Bernard, Balthazar Potet, and Nicolas Huloux — <i>Aflokkat, France; Aix Marseille Univ, CNRS, PRISM, France</i>	14
Human Recognition Performance of Simple Spatial Vibrotactile Patterns on the Torso Junwoo Kim, Heeyeon Kim, Chaeyong Park, and Seungmoon Choi — <i>Pohang University of Science and Technology (POSTECH), South Korea</i>	20

Oral Session 1B Wearable Haptics 1

Interpersonal Vibrotactile Phantom Sensation between Hands via Actuated Bracelets Kenta Ebina and Taku Hachisu — <i>University of Tsukuba, Japan</i>	28
WriMouCon: Wrist-Mounted Haptic Controller for Rendering Physical Properties in Virtual Reality Minjae Jo, DongKyu Kwak, and Sang Ho Yoon — <i>Korea Advanced Institute of Science and Technology, South Korea</i>	34
Information Transfer of Full-Body Vibrotactile Stimuli: An Initial Study with One to Three Sequential Vibrations Jaejun Park, Junwoo Kim, Chaeyong Park, Sangyo Han, Junseok Park, and Seungmoon Choi — <i>Pohang University of Science and Technology, South Korea; Pohang University of Science and Technology (POSTECH), South Korea; ETRI, South Korea</i>	41
A Magnetic Soft Device for Tactile Haptic Actuation of the Fingertip Sarah Costrell, Mahirah Alam, Roberta L. Klatzky, Michael E. McHenry, Lynn M. Walker, and Melisa Orta Martinez — <i>Carnegie Mellon University, USA; Carnegie Mellon, USA</i>	48
Design and Evaluation of a Multimodal Haptic Vest Bora Celebi, Müge Cavdan, and Knut Drewing — <i>Justus Liebig University, Germany</i>	56
The Impact of Haptic Feedback During Sudden, Rapid Virtual Interactions Nizamettin Taha Tanacar, Moaaz Hudhud Mughrabi, Anil Ufuk Batmaz, Daniele Leonardis, and Mine Sarac — <i>Kadir Has University, Turkey; Concordia University, Canada; Scuola Superiore Sant'Anna, Italy</i>	64
Wireless Dual Mode Haptic Thimble based on Magnetoactive Rubber Yong Hae Heo, Mohammad Shadman Hashem, Gyubin An, Hyun-Jeong Kim, Dong-Soo Choi, Seokhee Jeon, and Sang-Youn Kim — <i>Korea University of Technology and Education, South Korea; Kyung Hee University, South Korea; Kumoh National Institute of Technology, South Korea</i>	71

Oral Session 2A Haptic Applications in Social Interactions

Fostering Social Empathy in VR through Physiologically Based Affective Haptic Feedback Jeanne Hecquard, Justine Saint-Aubert, Ferran Argelaguet Sanz, Claudio Pacchierotti, Anatole Lécuyer, and Marc J.-M. Macé — <i>Inria, France; Inria Bretagne-Atlantique, France; CNRS, France; Rennes 1, France</i>	78
Human-Delivered Brushstroke Characterization Using an Instrumented Brush Focused on Torque Zackary Todd Landsman, Anika Kao, and Gregory John Gerling — <i>University of Virginia, USA</i>	85

Mediated Social Touching: Haptic Feedback Affects Social Experience of Touch Initiators Martin Maunsbach, Kasper Hornbæk, and Hasti Seifi — University of Copenhagen, Denmark; Arizona State University, USA	93
Oral Session 2B Surface Haptics	
Concurrent Haptic, Audio, and Visual Data Set During Bare Finger Interaction with Textured Surfaces Alexis William Marcel Devillard, Aruna Ramasamy, Damien Faux, Vincent Hayward, and Etienne Burdet — Imperial College, UK; Ecole Normale Supérieure, France; Actronika SAS, France; Actronika, France; Institut des Systèmes Intelligent et de Robotique, France; Imperial College London, UK	101
Dynamic Feedback in Wave-Mediated Surface Haptics: A Modular Platform Dustin Thomas Goetz, Gregory Reardon, Max Linnander, and Yon Visell — University of California Santa Barbara, USA; University of California, Santa Barbara, USA	107
Oral Session 3A Multimodal Interactions	
Manipulation of Body Sway Interpretation through Kinesthetic Illusion Induced by Ankles Vibration Eifu Narita, Shota Nakayama, Mitsuki Manabe, Keigo Ushiyama, Satoshi Tanaka, Izumi Mizoguchi, and Hiroyuki Kajimoto — University of Electro-Communications, Japan	114
Exploring Human Response Times to Combinations of Audio, Haptic, and Visual Stimuli from a Mobile Device Kyle T. Yoshida, Joel X. Kiernan, Allison M. Okamura, and Cara M. Nunez — Stanford University, USA; Cornell University, USA	121
Humans Struggle to Perceive Congruence in Visuo-Haptic Textures Jenna Fradin, Sinan D. Haliyo, and David Gueorguiev — Institut des Systèmes Intelligent et de Robotique, France; ISIR, France; CNRS, France; Sorbonne University, France	128
Communication is a Two-Way Street: Negotiating Driving Intent through a Shape-Changing Steering Wheel Hannah Baez, Akshay Bhardwaj, Jean Costa, John Gideon, Sile O'Modhrain, Nadine Sarter, and Brent Gillespie — University of Michigan, USA; Toyota Research Institute, USA	134
Training to Understand Complex Haptic Phrases: A Longitudinal Investigation Mauricio Fontana de Vargas, David Marino, Antoine Weill-Duflos, and Jeremy R. Cooperstock — McGill University, Canada	141
Oral Session 3B Vibrotactile and Electrotactile Displays	
Perceptual Simultaneity Between Vibrotactile and Impact Stimuli Chaeyong Park and Seungmoon Choi — Pohang University of Science and Technology (POSTECH), South Korea	148
Vibrotactile Display of Distance Information in a Virtual Object Exploration Task Johannes Rueschen and Hong Z. Tan — Purdue University, USA	156
Spatiotemporal Perception of Single Overlapped Vibrotactile Stimulation to Multiple Body Locations Takumi Kuhara, Kakagu Komazaki, Junji Watanabe, and Yoshihiro Tanaka — Nagoya Institute of Technology, Japan; Nippon Telegraph and Telephone Corporation, Japan; NTT Communication Science Laboratories, Japan	162
Naturalistic Vibrotactile Feedback Could Facilitate Telerobotic Assembly on Construction Sites Yijie Gong, Bernard Javot, Anja Patricia Regina Lauer, Oliver Sawodny, and Katherine J. Kuchenbecker — Max Planck Institute for Intelligent Systems, Germany; University of Stuttgart, Germany	169
Oral Session 4A Neuroscience of Touch and Motor Control	
Neural Correlates of Cooperation during Interactive Visuomotor Task: An fNIRS Hyperscanning Study Yilei Zheng, Shiyi Liu, Bohao Tian, Yuru Zhang, and Dangxiao Wang — Beijing Information Science and Technology University, China; Beihang University, China; State Key Laboratory of Virtual Reality Technology and Systems, China	176
Spatiotemporal Organization of Touch Information in Tactile Neuron Population Responses Neeli Tummala, Yitian Shao, and Yon Visell — University of California, Santa Barbara, USA; Technische Universität Dresden, Germany	183
A Wearable System Integrating Force Myography and Skin Stretch Feedback toward Force Skill Learning Arata Horie, Yunao Zheng, and Masahiko Inami — The University of Tokyo, Japan	190
Measurement of Rhythmic Movements in Street Dance for Quantifying Movement Timing Skills Ritsuko Kiso, Yuko Hashimoto, and Masashi Nakatani — Keio University, Japan; Ochanomizu University, Japan	197
Tactile Feedback Involving Actual Operation for Motor Skill Learning Hikari Yukawa, Moena Tsuruoka, Takayuki Kodama, Masashi Odagiri, Masayuki Sato, Michiya Takeda, Masahiko Kurachi, and Yoshihiro Tanaka — Nagoya Institute of Technology, Japan; Kyoto Tachibana University, Japan; Konica Minolta, Japan; Konica Minolta INC., Japan	203

Oral Session 4B Mid-Air Haptic Displays

Performance Evaluation of Airborne Ultrasound Focus Measurement Using Thermal Imaging on the Surface of a Finger

Sota Iwabuchi, Ryoya Onishi, Shun Suzuki, Takaaki Kamigaki, Yasutoshi Makino, and Hiroyuki Shinoda — University of Tokyo, Japan 210

Oral Session 5A Thermal Displays and Illusions

Modeling and Simulation of Thermal Grill Illusion Using Neurophysiological Theory

Subhankar Karmakar, Madhan Kumar Vasudevan, and Manivannan Muniyandi — Indian Institute of Technology Madras, India 216

Spatially Continuous Non-Contact Cold Sensation Presentation Based on Low-Temperature Airflows

Koyo Makino, Jiayi Xu, Akiko Kaneko, Naoto Ienaga, and Yoshihiro Kuroda — University of Tsukuba, Japan 223

Determination of the Thermal-Tactile Simultaneity Window for Multisensory Cutaneous Displays

Takuya Jodai, Masahiko Terao, Lynette Jones, and Hsin-Ni Ho — Kyushu University, Japan; Yamaguchi University, Japan; Massachusetts Institute of Technology, USA 230

Perception of Friction-Related Cues Induced by Temperature Variation on a Surface Display

Matej Mayet, Jean-Loïc Le Carrou, and David Gueorguiev — Institut Jean Le Rond D'Alembert, France; CNRS, France; Sorbonne Université, France; ISIR, France 237

Oral Session 5B Haptic Devices and Sensors

Optical Measurements of the Skin Surface to Infer Bilateral Distinctions in Myofascial Tissue Stiffness

Anika Kao, Zackary Todd Landsman, M. Terry Loghmani, and Gregory John Gerling — University of Virginia, USA; Indiana University, USA 244

Flexos: A Portable, SEA-Based Shoulder Exoskeleton with Hyper-redundant Kinematics for Weight Lifting Assistance

Gianluca Rinaldi, Luca Tiseni, Michele Xiloyannis, Lorenzo Masia, Antonio Frisoli, and Domenico Chiaradia — Sant'Anna School of Advanced Studies, Italy; Akina, Switzerland; Heidelberg University, Germany 252

Oral Session 6A Control and Haptic Rendering

Haptic Rendering of Dynamic Hand Interaction for an Impedance-Controlled Glove

Qianqian Tong, Weipeng Shen, Dangxiao Wang, and Miguel A. Otaduy — Peng Cheng Laboratory, China; Universidad Rey Juan Carlos, Spain; Beihang University, China 259

Shaping Human Movement via Bimanually-Dependent Haptic Force Feedback

Jacob R. Boehm, Ann Majewicz Fey, and Nicholas P. Fey — The University of Texas at Austin, USA; University of Texas at Austin, USA 266

CatBoost for Haptic Modeling of Homogeneous Viscoelastic Deformable Objects

Gautam Kumar, Shashi Prakash, and Amit Bhardwaj — Indian Institute of Technology Jodhpur, India; IIT Jodhpur, India 273

Physics Engine-Based Whole-Hand Haptic Rendering for Sensorimotor Neurorehabilitation

Raphael Rätz and Laura Marchal-Crespo — University of Bern, Switzerland; Delft University of Technology, Netherlands 279

Oral Session 6B Wearable Haptics 2

Wearable Sensory Substitution for Proprioception via Deep Pressure

Sreela Kodali, Brian Vuong, Thomas Bulea, Alexander Chesler, Carsten Bönnemann, and Allison M. Okamura — Stanford University, USA; National Institutes of Health, USA 286

A Miniature Direct-Drive Hydraulic Actuator for Wearable Haptic Devices based on Ferrofluid Magnetohydrodynamic Levitation

Daniele Leonardi, Domenico Chiaradia, and Antonio Frisoli — Scuola Superiore Sant'Anna of Pisa, Italy 293

Fingertip Wearable High-resolution Electrohydraulic Interface for Multimodal Haptics

Purnendu, Jess Hartcher-O'Brien, Vatsal Mehta, Nicholas Colonese, Aakar Gupta, Carson J. Bruns, and Priyanshu Agarwal — Meta, USA; University of Colorado Boulder, USA 299

Oral Session 7A Perception 2

Realism of Visual, Auditory, and Haptic Cues in Phenomenal Causality

Elyse D. Z. Chase, Tobias Gerstenberg, and Sean Follmer — Stanford University, USA 306

The Effects of Movement Direction and Glove on Spatial Frequency Discrimination in Oriented Textures

Didem Katircilar and Knut Drewing — Justus Liebig University Giessen, Germany; Giessen University, Germany 313

Influence of Electrical Stimulation Intensity on the Perception of Piquancy Masaki Ohno, Kazuma Aoyama, Tomohiro Amemiya, Hideaki Kuzuoka, Keigo Matsumoto, and Takuji Narumi — <i>University of Tokyo, Japan; Gunma University, Japan</i>	319
Controlling Human Perception of Haptic Profiles Using Contextual Cues Derek Van Delden, Alison Jenkins, William Singhose, Franziska Schlagenauf, and Kelly Dobson — <i>Georgia Tech, USA; Google, USA</i>	326
Oral Session 7B Robotics Applications and Teleoperation	
Towards Differential Magnetic Force Sensing for Ultrasound Teleoperation David Black, Amir Hossein Hadi Hosseiniabadi, Nicholas Rangga Pradnyawira, Maxime Pol, Mika Nogami, and Tim Salcudean — <i>University of British Columbia, Canada; École Polytechnique, France</i>	333
Optimized Time-Domain Control of Passive Haptic Teleoperation Systems for Multi-DoF Interaction Gianni Bianchini, Davide Barcelli, Domenico Prattichizzo, and Claudio Pacchierotti — <i>Università di Siena, Italy; University of Siena, Italy; CNRS, France</i>	340
Active Haptic Exploration Based on Dual-Stage Perception for Object Recognition Pakorn Uttayopas, Xiaoxiao Cheng, and Etienne Burdet — <i>Imperial College London, UK</i>	347
TP Posters Day 2	
Temporal Detection Threshold of Audio-Tactile Delays under Conditions of Active Touch with and without a Visual Cue Detjon Brahimaj, Giulia Esposito, Arthur Courtin, Andre Mouraux, Frederic GIRAUD, Betty SEMAIL, and Olivier Collignon — <i>University of Lille, France; Université catholique de Louvain, Belgium; Université de Lille, France</i>	354
3D Shape Presentation by Combination of Force Feedback and Electro-tactile Stimulation Yui Suga, Masahiro Miyakami, Izumi Mizoguchi, and Hiroyuki Kajimoto — <i>University of Electro-Communications, Japan</i>	361
Implementation and Evaluation of a Vibrotactile Assisted Monitoring and Correction System for Partial Weight-Bearing in Lower Extremities Øystein Bjelland, William Gulliksen, Arkadiusz Damian Kwiatkowski, Martin Skavø, Håkon Isern, Mohammadamin Shayestehpour, Martin Steinert, Alf-Inge Hellevik, and Robin T. Bye — <i>Norwegian University of Science and Technology, Norway; NTNU TrollLABS, Norway; Ålesund General Hospital, Norway</i>	368
1-D Manual Tracing Based on a High Density Haptic Stimulation Grid: A Pilot Effort Brendan Driscoll, Ming Liu, and Helen Huang — <i>North Carolina State University, USA</i>	375
Portable Self-propelled Force Feedback Device Ayaka Fukasawa, Riho Taniguchi, Takumi SATO, and Shoichi Hasegawa — <i>Tokyo Institute of Technology, Japan</i>	382
Wearable 3D Shape Display for Dynamic Interfaces Rendering Bilige Yang, Benjamin Stephens-Fripp, Priyanshu Agarwal, Sonny Chan, Nathan Usevitch, Andrew Stanley, and Yatian Qu — <i>Meta, USA; Yale University, USA</i>	389
TP Posters Day 3	
Easy-to-Recognize Bump Shapes Using Only Lateral Force Cues for Real and Virtual Surfaces Mirai Azechi and Shogo Okamoto — <i>Tokyo Metropolitan University, Japan</i>	397
Enhancing Perceived Resistance and Propulsion by Combining Pseudo-haptics and Pulling Illusion Tomohiro Kawagishi, Yuki Ban, Yusuke Ujитоko, and Shinichi Warisawa — <i>University of Tokyo, Japan; NTT Communication Science Laboratories, Japan</i>	403
An Exploration of Just Noticeable Differences in Mid-Air Haptics Katarzyna Wojna, Orestis Georgiou, David Beattie, William Frier, Michael Wright, and Christof Lutteroth — <i>University of Bath, UK; Ultraleap, UK; Ultrahaptics, UK</i>	410
The Influence of Surface Roughness and Surface Size on Perceived Pleasantness Lisa Pui Yee Lin, Müge Cavadan, Katja Doerschner, and Knut Drewing — <i>Justus-Liebig University Giessen, Germany; Justus Liebig University Giessen, Germany; Giessen University, Germany</i>	417
Effects on Perception when Removing One Frequency Component from Two Harmonic Vibrations Keisuke Tozuka and Hiroshi Igarashi — <i>Tokyo Denki University, Japan</i>	425
Identifying Human Grasp Properties During Robot-to-Human Handovers Paul Pacaud, etienne chassaing, Yilin Cai, Connor Yako, and Kenneth Salisbury — <i>Stanford University, USA; CentraleSupélec-Paris Saclay, France; Carnegie Mellon University, USA</i>	432

TP Posters Day 4

Transparent, High-Force, and High-Stiffness Control of Haptic Actuators with Backlash Patrick Dills and Michael Zinn — <i>University of Wisconsin - Madison, USA</i>	439
An Extended Virtual Proxy Haptic Algorithm for Dexterous Manipulation in Virtual Environments Aldo Fabrizio Galvan, Job Donaldo Ramirez, Ashish Deshpande, and Ann Majewicz Fey — <i>University of Texas - Austin, USA</i>	446
Handheld Haptic Device with Coupled Bidirectional Input Megh Doshi, Michael Hagenow, Robert Radwin, Michael Gleicher, Bilge Mutlu, and Michael Zinn — <i>University of Wisconsin-Madison, USA; University of Wisconsin- Madison, USA; University of Wisconsin - Madison, USA</i>	453
A User Study of a Cable Haptic Interface with a Reconfigurable Structure Bastien Jacques Étienne Poitrimol and Hiroshi Igarashi — <i>Tokyo Denki University, Japan; Tokyo Denki University, Japan</i>	460
Haptic Mushroom: A 3-DoF Shape-Changing Encounter-Type Haptic Device with Interchangeable End-Effectors Lisheng Kuang, Francesco Chinello, Paolo Robuffo Giordano, Maud Marchal, and Claudio Pachierotti — <i>CNRS, France; Aarhus University, Denmark; Univ. Rennes, INSA, IRISA, Inria, France; Institut Universitaire de France, France</i>	467
Dynamic Pattern Recognition with Localised Surface Haptics and Apparent Motion Mathilde Jeannin, Ayoub Ben Dhiab, Charles Hudin, and Sabrina Panéels — <i>LIX, France; Université Paris-Saclay, CEA, List, France</i>	474
Author Index	481