Lecture Notes in Computer Science 10909

Commenced Publication in 1973
Founding and Former Series Editors:
Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Editorial Board

David Hutchison
Lancaster University, Lancaster, UK
Takeo Kanade
Carnegie Mellon University, Pittsburgh, PA, USA
Josef Kittler
University of Surrey, Guildford, UK
Jon M. Kleinberg
Cornell University, Ithaca, NY, USA
Friedemann Mattern
ETH Zurich, Zurich, Switzerland
John C. Mitchell
Stanford University, Stanford, CA, USA
Moni Naor
Weizmann Institute of Science, Rehovot, Israel
C. Pandu Rangan
Indian Institute of Technology Madras, Chennai, India
Bernhard Steffen
TU Dortmund University, Dortmund, Germany
Demetri Terzopoulos
University of California, Los Angeles, CA, USA
Doug Tygar
University of California, Berkeley, CA, USA
Gerhard Weikum
Max Planck Institute for Informatics, Saarbrücken, Germany

More information about this series at http://www.springer.com/series/7409

Jessie Y. C. Chen · Gino Fragomeni (Eds.)

Virtual, Augmented and Mixed Reality

Interaction, Navigation, Visualization, Embodiment, and Simulation

10th International Conference, VAMR 2018
Held as Part of HCI International 2018
Las Vegas, NV, USA, July 15–20, 2018
Proceedings, Part I

Springer

Editors
Jessie Y. C. Chen
US Army Research Laboratory
Aberdeen Proving Ground, MD
USA

Gino Fragomeni
US Army Research Laboratory
Orlando, FL
USA

ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Computer Science
ISBN 978-3-319-91580-7 ISBN 978-3-319-91581-4 (eBook)
https://doi.org/10.1007/978-3-319-91581-4

Library of Congress Control Number: 2018944280

LNCS Sublibrary: SL3 – Information Systems and Applications, incl. Internet/Web, and HCI

© Springer International Publishing AG, part of Springer Nature 2018
This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by the registered company Springer International Publishing AG
part of Springer Nature
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Foreword

The 20th International Conference on Human-Computer Interaction, HCI International 2018, was held in Las Vegas, NV, USA, during July 15–20, 2018. The event incorporated the 14 conferences/thematic areas listed on the following page.

A total of 4,373 individuals from academia, research institutes, industry, and governmental agencies from 76 countries submitted contributions, and 1,170 papers and 195 posters have been included in the proceedings. These contributions address the latest research and development efforts and highlight the human aspects of design and use of computing systems. The contributions thoroughly cover the entire field of human-computer interaction, addressing major advances in knowledge and effective use of computers in a variety of application areas. The volumes constituting the full set of the conference proceedings are listed in the following pages.

I would like to thank the program board chairs and the members of the program boards of all thematic areas and affiliated conferences for their contribution to the highest scientific quality and the overall success of the HCI International 2018 conference.

This conference would not have been possible without the continuous and unwavering support and advice of the founder, Conference General Chair Emeritus and Conference Scientific Advisor Prof. Gavriel Salvendy. For his outstanding efforts, I would like to express my appreciation to the communications chair and editor of *HCI International News*, Dr. Abbas Moallem.

July 2018 Constantine Stephanidis

HCI International 2018 Thematic Areas and Affiliated Conferences

Thematic areas:

- Human-Computer Interaction (HCI 2018)
- Human Interface and the Management of Information (HIMI 2018)

Affiliated conferences:

- 15th International Conference on Engineering Psychology and Cognitive Ergonomics (EPCE 2018)
- 12th International Conference on Universal Access in Human-Computer Interaction (UAHCI 2018)
- 10th International Conference on Virtual, Augmented, and Mixed Reality (VAMR 2018)
- 10th International Conference on Cross-Cultural Design (CCD 2018)
- 10th International Conference on Social Computing and Social Media (SCSM 2018)
- 12th International Conference on Augmented Cognition (AC 2018)
- 9th International Conference on Digital Human Modeling and Applications in Health, Safety, Ergonomics, and Risk Management (DHM 2018)
- 7th International Conference on Design, User Experience, and Usability (DUXU 2018)
- 6th International Conference on Distributed, Ambient, and Pervasive Interactions (DAPI 2018)
- 5th International Conference on HCI in Business, Government, and Organizations (HCIBGO)
- 5th International Conference on Learning and Collaboration Technologies (LCT 2018)
- 4th International Conference on Human Aspects of IT for the Aged Population (ITAP 2018)

Conference Proceedings Volumes Full List

1. LNCS 10901, Human-Computer Interaction: Theories, Methods, and Human Issues (Part I), edited by Masaaki Kurosu
2. LNCS 10902, Human-Computer Interaction: Interaction in Context (Part II), edited by Masaaki Kurosu
3. LNCS 10903, Human-Computer Interaction: Interaction Technologies (Part III), edited by Masaaki Kurosu
4. LNCS 10904, Human Interface and the Management of Information: Interaction, Visualization, and Analytics (Part I), edited by Sakae Yamamoto and Hirohiko Mori
5. LNCS 10905, Human Interface and the Management of Information: Information in Applications and Services (Part II), edited by Sakae Yamamoto and Hirohiko Mori
6. LNAI 10906, Engineering Psychology and Cognitive Ergonomics, edited by Don Harris
7. LNCS 10907, Universal Access in Human-Computer Interaction: Methods, Technologies, and Users (Part I), edited by Margherita Antona and Constantine Stephanidis
8. LNCS 10908, Universal Access in Human-Computer Interaction: Virtual, Augmented, and Intelligent Environments (Part II), edited by Margherita Antona and Constantine Stephanidis
9. LNCS 10909, Virtual, Augmented and Mixed Reality: Interaction, Navigation, Visualization, Embodiment, and Simulation (Part I), edited by Jessie Y. C. Chen and Gino Fragomeni
10. LNCS 10910, Virtual, Augmented and Mixed Reality: Applications in Health, Cultural Heritage, and Industry (Part II), edited by Jessie Y. C. Chen and Gino Fragomeni
11. LNCS 10911, Cross-Cultural Design: Methods, Tools, and Users (Part I), edited by Pei-Luen Patrick Rau
12. LNCS 10912, Cross-Cultural Design: Applications in Cultural Heritage, Creativity, and Social Development (Part II), edited by Pei-Luen Patrick Rau
13. LNCS 10913, Social Computing and Social Media: User Experience and Behavior (Part I), edited by Gabriele Meiselwitz
14. LNCS 10914, Social Computing and Social Media: Technologies and Analytics (Part II), edited by Gabriele Meiselwitz
15. LNAI 10915, Augmented Cognition: Intelligent Technologies (Part I), edited by Dylan D. Schmorrow and Cali M. Fidopiastis
16. LNAI 10916, Augmented Cognition: Users and Contexts (Part II), edited by Dylan D. Schmorrow and Cali M. Fidopiastis
17. LNCS 10917, Digital Human Modeling and Applications in Health, Safety, Ergonomics, and Risk Management, edited by Vincent G. Duffy
18. LNCS 10918, Design, User Experience, and Usability: Theory and Practice (Part I), edited by Aaron Marcus and Wentao Wang

19. LNCS 10919, Design, User Experience, and Usability: Designing Interactions (Part II), edited by Aaron Marcus and Wentao Wang
20. LNCS 10920, Design, User Experience, and Usability: Users, Contexts, and Case Studies (Part III), edited by Aaron Marcus and Wentao Wang
21. LNCS 10921, Distributed, Ambient, and Pervasive Interactions: Understanding Humans (Part I), edited by Norbert Streitz and Shin'ichi Konomi
22. LNCS 10922, Distributed, Ambient, and Pervasive Interactions: Technologies and Contexts (Part II), edited by Norbert Streitz and Shin'ichi Konomi
23. LNCS 10923, HCI in Business, Government, and Organizations, edited by Fiona Fui-Hoon Nah and Bo Sophia Xiao
24. LNCS 10924, Learning and Collaboration Technologies: Design, Development and Technological Innovation (Part I), edited by Panayiotis Zaphiris and Andri Ioannou
25. LNCS 10925, Learning and Collaboration Technologies: Learning and Teaching (Part II), edited by Panayiotis Zaphiris and Andri Ioannou
26. LNCS 10926, Human Aspects of IT for the Aged Population: Acceptance, Communication, and Participation (Part I), edited by Jia Zhou and Gavriel Salvendy
27. LNCS 10927, Human Aspects of IT for the Aged Population: Applications in Health, Assistance, and Entertainment (Part II), edited by Jia Zhou and Gavriel Salvendy
28. CCIS 850, HCI International 2018 Posters Extended Abstracts (Part I), edited by Constantine Stephanidis
29. CCIS 851, HCI International 2018 Posters Extended Abstracts (Part II), edited by Constantine Stephanidis
30. CCIS 852, HCI International 2018 Posters Extended Abstracts (Part III), edited by Constantine Stephanidis

http://2018.hci.international/proceedings

10th International Conference on Virtual, Augmented and Mixed Reality

Program Board Chair(s): **Jessie Y. C. Chen and Gino Fragomeni, *USA***

- Jacob Crandall, USA
- Tami Griffith, USA
- Stephanie J. Lackey, USA
- Fotis Liarokapis, Czech Republic
- Joseph Lyons, USA
- Philip Mangos, USA
- Amar Marathe, USA
- Rafael Radkowski, USA
- Maria Olinda Rodas, USA
- José San Martín, Spain
- Peter A. Smith, USA
- Tom Williams, USA
- Denny Yu, USA

The full list with the Program Board Chairs and the members of the Program Boards of all thematic areas and affiliated conferences is available online at:

http://www.hci.international/board-members-2018.php

HCI International 2019

The 21st International Conference on Human-Computer Interaction, HCI International 2019, will be held jointly with the affiliated conferences in Orlando, FL, USA, at Walt Disney World Swan and Dolphin Resort, July 26–31, 2019. It will cover a broad spectrum of themes related to Human-Computer Interaction, including theoretical issues, methods, tools, processes, and case studies in HCI design, as well as novel interaction techniques, interfaces, and applications. The proceedings will be published by Springer. More information will be available on the conference website: http://2019.hci.international/.

General Chair
Prof. Constantine Stephanidis
University of Crete and ICS-FORTH
Heraklion, Crete, Greece
E-mail: general_chair@hcii2019.org

http://2019.hci.international/

Contents – Part I

Interaction, Navigation and Visualization in VAMR

Determining Which Touch Gestures Are Commonly Used When Visualizing Physics Problems in Augmented Reality 3
Marta del Rio Guerra, Jorge Martín-Gutiérrez, Raúl Vargas-Lizárraga, and Israel Garza-Bernal

Element Selection of Three-Dimensional Objects in Virtual Reality 13
Dylan Fox, Sophie So Yeon Park, Amol Borcar, Anna Brewer, and Joshua Yang

Design and Assessment of Two Handling Interaction Techniques for 3D Virtual Objects Using the Myo Armband 30
Yadira Garnica Bonome, Abel González Mondéjar, Renato Cherullo de Oliveira, Eduardo de Albuquerque, and Alberto Raposo

Surface Prediction for Spatial Augmented Reality 43
Adam Gomes, Keegan Fernandes, and David Wang

Real-Time Motion Capture on a Budget 56
Tami Griffith, Tabitha Dwyer, and Jennie Ablanedo

A Novel Way of Estimating a User's Focus of Attention in a Virtual Environment 71
Xuanchao He and Zhejun Liu

Get Well Soon! Human Factors' Influence on Cybersickness After Redirected Walking Exposure in Virtual Reality 82
Julian Hildebrandt, Patric Schmitz, André Calero Valdez, Leif Kobbelt, and Martina Ziefle

Dynamic Keypad – Digit Shuffling for Secure PIN Entry in a Virtual World 102
Andrew Holland and Tony Morelli

VR Evaluation of Motion Sickness Solution in Automated Driving 112
Quinate Chioma Ihemedu-Steinke, Prashanth Halady, Gerrit Meixner, and Michael Weber

Enactive Steering of an Experiential Model of the Atmosphere 126
Brandon Mechtley, Christopher Roberts, Julian Stein, Benjamin Nandin, and Xin Wei Sha

Reconstruction by Low Cost Software Based on Photogrammetry as a Reverse Engineering Process 145
Dolores Parras, Francisco Cavas-Martínez, José Nieto, Francisco J. F. Cañavate, and Daniel García Fernández-Pacheco

Simulation Sickness Evaluation While Using a Fully Autonomous Car in a Head Mounted Display Virtual Environment 155
Stanislava Rangelova, Daniel Decker, Marc Eckel, and Elisabeth Andre

Visualizing Software Architectures in Virtual Reality with an Island Metaphor 168
Andreas Schreiber and Martin Misiak

Interaction in Virtual Environments - How to Control the Environment by Using VR-Glasses in the Most Immersive Way 183
Barbara Streppel, Dorothea Pantförder, and Birgit Vogel-Heuser

Sensor Data Fusion Framework to Improve Holographic Object Registration Accuracy for a Shared Augmented Reality Mission Planning Scenario 202
Simon Su, Vincent Perry, Qiang Guan, Andrew Durkee, Alexis R. Neigel, and Sue Kase

Using Body Movements for Running in Realistic 3D Map 215
Adhi Yudana Svarajati and Jiro Tanaka

VRowser: A Virtual Reality Parallel Web Browser 230
Shuma Toyama, Mohammed Al Sada, and Tatsuo Nakajima

Construction of Experimental System SPIDAR-HS for Designing VR Guidelines Based on Physiological Behavior Measurement 245
Ryuki Tsukikawa, Ryoto Tomita, Kanata Nozawa, Issei Ohashi, Hiroki Horiuchi, Kentaro Kotani, Daiji Kobayashi, Takehiko Yamaguchi, Makoto Sato, Sakae Yamamoto, and Tetsuya Harada

Augmented, Mixed, and Virtual Reality Enabling of Robot Deixis 257
Tom Williams, Nhan Tran, Josh Rands, and Neil T. Dantam

Embodiment, Communication and Collaboration in VAMR

Is This Person Real? Avatar Stylization and Its Influence on Human Perception in a Counseling Training Environment 279
Jennie Ablanedo, Elaine Fairchild, Tami Griffith, and Christopher Rodeheffer

Virtually Empathetic?: Examining the Effects of Virtual Reality Storytelling on Empathy 290
EunSeo Bang and Caglar Yildirim

The Role of Psychophysiological Measures as Implicit Communication Within Mixed-Initiative Teams 299
Kim Drnec, Greg Gremillion, Daniel Donavanik, Jonroy D. Canady, Corey Atwater, Evan Carter, Ben A. Haynes, Amar R. Marathe, and Jason S. Metcalfe

Extending Embodied Interactions in Mixed Reality Environments 314
Mohamed Handosa, Hendrik Schulze, Denis Gračanin, Matthew Tucker, and Mark Manuel

Interaction of Distant and Local Users in a Collaborative Virtual Environment 328
Adrian H. Hoppe, Roland Reeb, Florian van de Camp, and Rainer Stiefelhagen

Bidirectional Communication for Effective Human-Agent Teaming 338
Amar R. Marathe, Kristin E. Schaefer, Arthur W. Evans, and Jason S. Metcalfe

PaolaChat: A Virtual Agent with Naturalistic Breathing 351
David Novick, Mahdokht Afravi, and Adriana Camacho

Quantifying Human Decision-Making: Implications for Bidirectional Communication in Human-Robot Teams 361
Kristin E. Schaefer, Brandon S. Perelman, Ralph W. Brewer, Julia L. Wright, Nicholas Roy, and Derya Aksaray

Education, Training and Simulation

A Maximum Likelihood Method for Estimating Performance in a Rapid Serial Visual Presentation Target-Detection Task 383
Jonroy D. Canady, Amar R. Marathe, David H. Herman, and Benjamin T. Files

Virtual Reality Training to Enhance Motor Skills 393
Matt Dombrowski, Ryan Buyssens, and Peter A. Smith

Examination of Effectiveness of a Performed Procedural Task Using Low-Cost Peripheral Devices in VR 403
Damian Grajewski, Paweł Buń, and Filip Górski

Study on the Quality of Experience Evaluation Metrics for Astronaut Virtual Training System 416
Xiangjie Kong, Yuqing Liu, and Ming An

Developing and Training Multi-gestural Prosthetic Arms 427
Albert Manero, John Sparkman, Matt Dombrowski, Ryan Buyssens, and Peter A. Smith

Virtual Reality Based Space Operations – A Study of ESA's Potential for VR Based Training and Simulation 438
Manuel Olbrich, Holger Graf, Jens Keil, Rüdiger Gad, Steffen Bamfaste, and Frank Nicolini

Guiding or Exploring? Finding the Right Way to Teach Students Structural Analysis with Augmented Reality 452
Rafael Radkowski, Aliye Karabulut-Ilgu, Yelda Turkan, Amir Behzadan, and An Chen

Assembly Training: Comparing the Effects of Head-Mounted Displays and Face-to-Face Training 462
Stefan Werrlich, Carolin Lorber, Phuc-Anh Nguyen, Carlos Emilio Franco Yanez, and Gunther Notni

Author Index 477

Contents – Part II

VAMR in Psychotherapy, Exercising and Health

A Case Study: Chronic Pain Patients' Preferences for Virtual Reality Games for Pain Distraction 3
Xin Tong, Weina Jin, Kathryn Cruz, Diane Gromala, Bernie Garret, and Tarnia Taverner

The Effect of Multimodal Feedback on Perceived Exertion on a VR Exercise Setting 12
Jon Ram Bruun-Pedersen, Morten G. Andersen, Mathias M. Clemmensen, Mads K. Didriksen, Emil J. Wittendorff, and Stefania Serafin

xR-Based Systems for Mindfulness Based Training in Clinical Settings 31
Mark R. Costa, Dessa Bergen-Cico, Rocio Hererro, Jessica Navarro, Rachel Razza, and Qiu Wang

A Mixed Reality Based Social Interactions Testbed: A Game Theory Approach 40
Archi Dasgupta, Nicole Buckingham, Denis Gračanin, Mohamed Handosa, and Reza Tasooji

Escape from the Dark Jungle: A 3D Audio Game for Emotion Regulation . . . 57
Jiangtao Gong, Yin Shi, Jue Wang, Danqing Shi, and Yingqing Xu

Virtual-Reality Videos to Relieve Depression 77
Syed Ali Hussain, Taiwoo Park, Irem Yildirim, Zihan Xiang, and Farha Abbasi

The Message Effect of Augmented Health Messages on Body 86
Soyoung Jung

Immersion in Virtual Reality Can Increase Exercise Motivation and Physical Performance 94
Gyoung Kim and Frank Biocca

Design of Virtual Reality Scenes with Variable Levels of Fear Evocation . . . 103
Dan Liao, Yanping Huang, Zhizhen Tan, Jiong Yang, and Xiangmin Xu

Scenes Design in Virtual Reality for Depression Assessment 116
Dan Liao, Lin Shu, Yanping Huang, Jiong Yang, and Xiangmin Xu

The Use of Virtual and Augmented Reality to Prevent the Physical Effects Caused by Diabetes Melitus Type 2: An Integrative Review 126
Leticia Neira-Tovar and Ivan Castilla Rodriguez

Reducing Fear or Anxiety by Simulating Breathing Movements as Physical Contact with an Unrelated Person 134
Shunsuke Yanaka, Motofumi Hattori, and Takayuki Kosaka

Virtual Reality for Cultural Heritage, Entertainment and Games

The Impact of Augmented Reality on Art Engagement: Liking, Impression of Learning, and Distraction 153
Tanja Aitamurto, Jean-Baptiste Boin, Kaiping Chen, Ahmed Cherif, and Skanda Shridhar

Following the White Rabbit: The Virtual Reality for Games 172
Paulo Carvalho

Cinematic Narration in VR – Rethinking Film Conventions for 360 Degrees 184
Michael Gödde, Frank Gabler, Dirk Siegmund, and Andreas Braun

Walking with Angest: Subjective Measures for Subjective Evaluation in a Walking Simulator Virtual Reality Game 202
Wilson Prata, Juan Oliveira, and Paulo Melo

AI-Based VR Earthquake Simulator 213
Ryota Suzuki, Ryoki Iitoi, Yue Qiu, Kenji Iwata, and Yutaka Satoh

Immercity: A Curation Content Application in Virtual and Augmented Reality 223
Jean-Daniel Taupiac, Nancy Rodriguez, and Olivier Strauss

VAIR Field - Multiple Mobile VR Shooting Sports 235
Masasuke Yasumoto and Takehiro Teraoka

Industrial and Military Applications

Command and Control Collaboration Sand Table (C2-CST) 249
Bryan L. Croft, Crisrael Lucero, David Neurnberger, Fred Greene, Allen Qiu, Roni Higgins, and Eric Gustafson

CAE/VR Integration – A Qualitative Assessment of Advanced Visualization for Interactive Conceptual Simulations (ICS) in Industrial Use 260
Holger Graf and André Stork

Augmented Reality and Mixed Reality Prototypes for Enhanced Mission Command/Battle Management Command and Control (BMC2) Execution . . . 272
Michael Jenkins, Arthur Wollocko, Alessandro Negri, and Ted Ficthl

Helmet-Mounted Displays to Support Off-Axis Pilot Spatial Orientation 289
Stephanie Kane and Ryan M. Kilgore

Augmented Reality Views: Discussing the Utility of Visual Elements by Mediation Means in Industrial AR from a Design Perspective 298
Jens Keil, Florian Schmitt, Timo Engelke, Holger Graf, and Manuel Olbrich

Usability Evaluation for Drone Mission Planning in Virtual Reality. 313
Yifei Liu, Nancy Yang, Alyssa Li, Jesse Paterson, David McPherson, Tom Cheng, and Allen Y. Yang

Cyber Vulnerability: An Attentional Dilemma. 331
Joseph B. Lyons, Mark A. Roebke, Philip Bobko, and Craig A. Cox

Trust in Autonomous Systems for Threat Analysis: A Simulation Methodology 341
Gerald Matthews, April Rose Panganiban, Rachel Bailey, and Jinchao Lin

MxR Framework for Uncertainty Based Explanation for Uncovering Adversarial Behavior 354
Adrienne Raglin, James Michealis, Mark Dennison, Andre Harrison, Theron Trout, and James Schaffer

Human-Agent Collaborative Decision-Making Framework for Naval Systems. 369
Maria Olinda Rodas, Jeff Waters, and Cheryl Putnam

360 Degree Mixed Reality Environment to Evaluate Interaction Design for Industrial Vehicles Including Head-Up and Head-Down Displays. 377
Markus Wallmyr, Daniel Kade, and Tobias Holstein

Author Index 393