

Founding Editors

Gerhard Goos

Karlsruhe Institute of Technology, Karlsruhe, Germany

Juris Hartmanis

Cornell University, Ithaca, NY, USA

Editorial Board Members

Elisa Bertino

Purdue University, West Lafayette, IN, USA

Wen Gao

Peking University, Beijing, China

Bernhard Steffen 

TU Dortmund University, Dortmund, Germany

Gerhard Woeginger 

RWTH Aachen, Aachen, Germany

Moti Yung

Columbia University, New York, NY, USA

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

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

HCI International 2020 – Late Breaking Papers

Virtual and Augmented Reality

22nd HCI International Conference, HCII 2020
Copenhagen, Denmark, July 19–24, 2020
Proceedings

Editors

Constantine Stephanidis
University of Crete and Foundation
for Research and Technology – Hellas
(FORTH)
Heraklion, Crete, Greece

Jessie Y. C. Chen
U.S. Army Research Laboratory
Aberdeen Proving Ground, MD, USA

Gino Fragomeni
U.S. Army Combat Capabilities
Development Command Soldier Center
Orlando, FL, USA

ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Computer Science
ISBN 978-3-030-59989-8 ISBN 978-3-030-59990-4 (eBook)
<https://doi.org/10.1007/978-3-030-59990-4>

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

© Springer Nature Switzerland AG 2020

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, expressed 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.

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

Foreword

The 22nd International Conference on Human-Computer Interaction, HCI International 2020 (HCII 2020), was planned to be held at the AC Bella Sky Hotel and Bella Center, Copenhagen, Denmark, during July 19–24, 2020. Due to the COVID-19 pandemic and the resolution of the Danish government not to allow events larger than 500 people to be hosted until September 1, 2020, HCII 2020 had to be held virtually. It incorporated the 21 thematic areas and affiliated conferences listed on the following page.

A total of 6,326 individuals from academia, research institutes, industry, and governmental agencies from 97 countries submitted contributions, and 1,439 papers and 238 posters were included in the volumes of the proceedings published before the conference. Additionally, 333 papers and 144 posters are included in the volumes of the proceedings published after the conference, as “Late Breaking Work” (papers and posters). These contributions address the latest research and development efforts in the field and highlight the human aspects of design and use of computing systems.

The volumes comprising the full set of the HCII 2020 conference proceedings are listed in the following pages and together they broadly cover the entire field of human-computer interaction, addressing major advances in knowledge and effective use of computers in a variety of application areas.

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 valuable contributions towards the highest scientific quality and the overall success of the HCI International 2020 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 2020

Constantine Stephanidis

HCI International 2020 Thematic Areas and Affiliated Conferences

Thematic Areas:

- HCI 2020: Human-Computer Interaction
- HIMI 2020: Human Interface and the Management of Information

Affiliated Conferences:

- EPCE: 17th International Conference on Engineering Psychology and Cognitive Ergonomics
- UAHCI: 14th International Conference on Universal Access in Human-Computer Interaction
- VAMR: 12th International Conference on Virtual, Augmented and Mixed Reality
- CCD: 12th International Conference on Cross-Cultural Design
- SCSM: 12th International Conference on Social Computing and Social Media
- AC: 14th International Conference on Augmented Cognition
- DHM: 11th International Conference on Digital Human Modeling & Applications in Health, Safety, Ergonomics & Risk Management
- DUXU: 9th International Conference on Design, User Experience and Usability
- DAPI: 8th International Conference on Distributed, Ambient and Pervasive Interactions
- HCIBGO: 7th International Conference on HCI in Business, Government and Organizations
- LCT: 7th International Conference on Learning and Collaboration Technologies
- ITAP: 6th International Conference on Human Aspects of IT for the Aged Population
- HCI-CPT: Second International Conference on HCI for Cybersecurity, Privacy and Trust
- HCI-Games: Second International Conference on HCI in Games
- MobiTAS: Second International Conference on HCI in Mobility, Transport and Automotive Systems
- AIS: Second International Conference on Adaptive Instructional Systems
- C&C: 8th International Conference on Culture and Computing
- MOBILE: First International Conference on Design, Operation and Evaluation of Mobile Communications
- AI-HCI: First International Conference on Artificial Intelligence in HCI

Conference Proceedings – Full List of Volumes

1. LNCS 12181, Human-Computer Interaction: Design and User Experience (Part I), edited by Masaaki Kurosu
2. LNCS 12182, Human-Computer Interaction: Multimodal and Natural Interaction (Part II), edited by Masaaki Kurosu
3. LNCS 12183, Human-Computer Interaction: Human Values and Quality of Life (Part III), edited by Masaaki Kurosu
4. LNCS 12184, Human Interface and the Management of Information: Designing Information (Part I), edited by Sakae Yamamoto and Hirohiko Mori
5. LNCS 12185, Human Interface and the Management of Information: Interacting with Information (Part II), edited by Sakae Yamamoto and Hirohiko Mori
6. LNAI 12186, Engineering Psychology and Cognitive Ergonomics: Mental Workload, Human Physiology, and Human Energy (Part I), edited by Don Harris and Wen-Chin Li
7. LNAI 12187, Engineering Psychology and Cognitive Ergonomics: Cognition and Design (Part II), edited by Don Harris and Wen-Chin Li
8. LNCS 12188, Universal Access in Human-Computer Interaction: Design Approaches and Supporting Technologies (Part I), edited by Margherita Antona and Constantine Stephanidis
9. LNCS 12189, Universal Access in Human-Computer Interaction: Applications and Practice (Part II), edited by Margherita Antona and Constantine Stephanidis
10. LNCS 12190, Virtual, Augmented and Mixed Reality: Design and Interaction (Part I), edited by Jessie Y.C. Chen and Gino Fragomeni
11. LNCS 12191, Virtual, Augmented and Mixed Reality: Industrial and Everyday Life Applications (Part II), edited by Jessie Y.C. Chen and Gino Fragomeni
12. LNCS 12192, Cross-Cultural Design: User Experience of Products, Services, and Intelligent Environments (Part I), edited by P.L. Patrick Rau
13. LNCS 12193, Cross-Cultural Design: Applications in Health, Learning, Communication, and Creativity (Part II), edited by P.L. Patrick Rau
14. LNCS 12194, Social Computing and Social Media: Design, Ethics, User Behavior, and Social Network Analysis (Part I), edited by Gabriele Meiselwitz
15. LNCS 12195, Social Computing and Social Media: Participation, User Experience, Consumer Experience, and Applications of Social Computing (Part II), edited by Gabriele Meiselwitz
16. LNAI 12196, Augmented Cognition: Theoretical and Technological Approaches (Part I), edited by Dylan D. Schmorow and Cali M. Fidopiastis
17. LNAI 12197, Augmented Cognition: Human Cognition and Behaviour (Part II), edited by Dylan D. Schmorow and Cali M. Fidopiastis

18. LNCS 12198, Digital Human Modeling & Applications in Health, Safety, Ergonomics & Risk Management: Posture, Motion and Health (Part I), edited by Vincent G. Duffy
19. LNCS 12199, Digital Human Modeling & Applications in Health, Safety, Ergonomics & Risk Management: Human Communication, Organization and Work (Part II), edited by Vincent G. Duffy
20. LNCS 12200, Design, User Experience, and Usability: Interaction Design (Part I), edited by Aaron Marcus and Elizabeth Rosenzweig
21. LNCS 12201, Design, User Experience, and Usability: Design for Contemporary Interactive Environments (Part II), edited by Aaron Marcus and Elizabeth Rosenzweig
22. LNCS 12202, Design, User Experience, and Usability: Case Studies in Public and Personal Interactive Systems (Part III), edited by Aaron Marcus and Elizabeth Rosenzweig
23. LNCS 12203, Distributed, Ambient and Pervasive Interactions, edited by Norbert Streitz and Shin'ichi Konomi
24. LNCS 12204, HCI in Business, Government and Organizations, edited by Fiona Fui-Hoon Nah and Keng Siau
25. LNCS 12205, Learning and Collaboration Technologies: Designing, Developing and Deploying Learning Experiences (Part I), edited by Panayiotis Zaphiris and Andri Ioannou
26. LNCS 12206, Learning and Collaboration Technologies: Human and Technology Ecosystems (Part II), edited by Panayiotis Zaphiris and Andri Ioannou
27. LNCS 12207, Human Aspects of IT for the Aged Population: Technologies, Design and User experience (Part I), edited by Qin Gao and Jia Zhou
28. LNCS 12208, Human Aspects of IT for the Aged Population: Healthy and Active Aging (Part II), edited by Qin Gao and Jia Zhou
29. LNCS 12209, Human Aspects of IT for the Aged Population: Technology and Society (Part III), edited by Qin Gao and Jia Zhou
30. LNCS 12210, HCI for Cybersecurity Privacy and Trust, edited by Abbas Moallem
31. LNCS 12211, HCI in Games, edited by Xiaowen Fang
32. LNCS 12212, HCI in Mobility, Transport and Automotive Systems: Automated Driving and In-Vehicle Experience Design (Part I), edited by Heidi Krömker
33. LNCS 12213, HCI in Mobility, Transport and Automotive Systems: Driving Behavior, Urban and Smart Mobility (Part II), edited by Heidi Krömker
34. LNCS 12214, Adaptive Instructional Systems, edited by Robert A. Sottilare and Jessica Schwarz
35. LNCS 12215, Culture and Computing, edited by Matthias Rauterberg
36. LNCS 12216, Design, Operation and Evaluation of Mobile Communications, edited by Gavriel Salvendy and June Wei
37. LNCS 12217, Artificial Intelligence in HCI, edited by Helmut Degen and Lauren Reinerman-Jones
38. CCIS 1224, HCI International 2020 Posters (Part I), edited by Constantine Stephanidis and Margherita Antona
39. CCIS 1225, HCI International 2020 Posters (Part II), edited by Constantine Stephanidis and Margherita Antona

40. CCIS 1226, HCI International 2020 Posters (Part III), edited by Constantine Stephanidis and Margherita Antona
41. LNCS 12423, HCI International 2020 – Late Breaking Papers: User Experience Design and Case Studies, edited by Constantine Stephanidis, Aaron Marcus, Elizabeth Rosenzweig, P.L. Patrick Rau, Abbas Moallem, and Matthias Rauterberg
42. LNCS 12424, HCI International 2020 – Late Breaking Papers: Multimodality and Intelligence, edited by Constantine Stephanidis, Masaaki Kurosu, Helmut Degen, and Lauren Reinerman-Jones
43. LNCS 12425, HCI International 2020 – Late Breaking Papers: Cognition, Learning and Games, edited by Constantine Stephanidis, Don Harris, Wen-Chin Li, Dylan D. Schmorow, Cali M. Fidopiastis, Panayiotis Zaphiris, Andri Ioannou, Xiaowen Fang, Robert Sottilare, and Jessica Schwarz
44. LNCS 12426, HCI International 2020 – Late Breaking Papers: Universal Access and Inclusive Design, edited by Constantine Stephanidis, Margherita Antona, Qin Gao, and Jia Zhou
45. LNCS 12427, HCI International 2020 – Late Breaking Papers: Interaction, Knowledge and Social Media, edited by Constantine Stephanidis, Gavriel Salvendy, June Way, Sakae Yamamoto, Hirohiko Mori, Gabriele Meiselwitz, Fiona Fui-Hoon Nah, and Keng Siau
46. LNCS 12428, HCI International 2020 – Late Breaking Papers: Virtual and Augmented Reality, edited by Constantine Stephanidis, Jessie Y.C. Chen, and Gino Fragomeni
47. LNCS 12429, HCI International 2020 – Late Breaking Papers: Digital Human Modeling and Ergonomics, Mobility and Intelligent Environments, edited by Constantine Stephanidis, Vincent G. Duffy, Norbert Streitz, Shin'ichi Konomi, and Heidi Krömker
48. CCIS 1293, HCI International 2020 – Late Breaking Posters (Part I), edited by Constantine Stephanidis, Margherita Antona, and Stavroula Ntoa
49. CCIS 1294, HCI International 2020 – Late Breaking Posters (Part II), edited by Constantine Stephanidis, Margherita Antona, and Stavroula Ntoa

<http://2020.hci.international/proceedings>



HCI International 2020 (HCII 2020)

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-2020.php>



HCI International 2021

The 23rd International Conference on Human-Computer Interaction, HCI International 2021 (HCII 2021), will be held jointly with the affiliated conferences in Washington DC, USA, at the Washington Hilton Hotel, July 24–29, 2021. It will cover a broad spectrum of themes related to human-computer interaction (HCI), 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://2021.hci.international/>

General Chair

Prof. Constantine Stephanidis

University of Crete and ICS-FORTH

Heraklion, Crete, Greece

Email: general_chair@hci2021.org

<http://2021.hci.international/>



Contents

Virtual, Augmented and Mixed Reality Design and Implementation

Haptic Helmet for Emergency Responses in Virtual and Live Environments	3
<i>Florian Alber, Sean Hackett, and Yang Cai</i>	
eTher – An Assistive Virtual Agent for Acrophobia Therapy in Virtual Reality	12
<i>Oana Bălan, Ștefania Cristea, Gabriela Moise, Livia Petrescu, Silviu Ivașcu, Alin Moldoveanu, Florica Moldoveanu, and Marius Leordeanu</i>	
A Color Design System in AR Guide Assembly	26
<i>Xupeng Cai, Shuxia Wang, Guangyao Xu, and Weiping He</i>	
An Augmented Reality Command and Control Sand Table Visualization of the User Interface Prototyping Toolkit (UIPT)	40
<i>Bryan Croft, Jeffrey D. Clarkson, Eric Voncolln, Alex Campos, Scott Patten, and Richard Roots</i>	
Exploring Augmented Reality as Craft Material	54
<i>Lauren Edlin, Yuanyuan Liu, Nick Bryan-Kinns, and Joshua Reiss</i>	
The Application of Urban AR Technology in Cultural Communication and Innovation	70
<i>Yueyun Fan and Yaqi Zheng</i>	
Reporting Strategy for VR Design Reviews	80
<i>Martin Gebert, Maximilian-Peter Dammann, Bernhard Saske, Wolfgang Steger, and Ralph Stelzer</i>	
Video Player Architecture for Virtual Reality on Mobile Devices	91
<i>Adriano M. Gil, Afonso R. Costa Jr., Atacilio C. Cunha, Thiago S. Figueira, and Antonio A. Silva</i>	
A Shader-Based Architecture for Virtual Reality Applications on Mobile Devices	101
<i>Adriano M. Gil and Thiago S. Figueira</i>	
Emotions Synthesis Using Spatio-Temporal Geometric Mesh	112
<i>Diego Addan Gonçalves and Eduardo Todt</i>	

An Augmented Reality Approach to 3D Solid Modeling and Demonstration	121
<i>Shu Han, Shuxia Wang, and Peng Wang</i>	
Quick Projection Mapping on Moving Object in the Manual Assembly Guidance.	141
<i>Weiping He, Bokai Zheng, Shuxia Wang, and Shouxia Wang</i>	
Design and Implementation of a Virtual Workstation for a Remote AFISO	152
<i>Thomas Hofmann, Jörn Jakobi, Marcus Biella, Christian Blessmann, Fabian Reuschling, and Tom Kamender</i>	
A Scene Classification Approach for Augmented Reality Devices	164
<i>Aasim Khurshid, Sergio Cleger, and Ricardo Grunitzki</i>	
Underwater Search and Discovery: From Serious Games to Virtual Reality	178
<i>Fotis Liarokapis, Iveta Vidová, Selma Rizvić, Stella Demesticha, and Dimitrios Skarlatos</i>	
Emergent Behaviour of Therapists in Virtual Reality Rehabilitation of Acquired Brain Injury	198
<i>Henrik Sæderup, Flaviu Vreme, Hans Pauli Arnoldson, Alexandru Diaconu, and Michael Boelstoft Holte</i>	
Improving Emergency Response Training and Decision Making Using a Collaborative Virtual Reality Environment for Building Evacuation	213
<i>Sharad Sharma</i>	
Text Entry in Virtual Reality: Implementation of FLIK Method and Text Entry Testbed	225
<i>Eduardo Soto and Robert J. Teather</i>	
Appropriately Representing Military Tasks for Human-Machine Teaming Research.	245
<i>Chad C. Tossell, Boyoung Kim, Bianca Donadio, Ewart J. de Visser, Ryan Holec, and Elizabeth Phillips</i>	
A Portable Measurement System for Spatially-Varying Reflectance Using Two Handheld Cameras.	266
<i>Zar Zar Tun, Seiji Tsunetsaki, Takashi Komuro, Shoji Yamamoto, and Norimichi Tsumura</i>	
Influence of Visual Gap of Avatar Joint Angle on Sense of Embodiment in VR Space Adjusted via C/D Ratio.	277
<i>Takehiko Yamaguchi, Hiroaki Tama, Yuya Ota, Yukiko Watabe, Sakae Yamamoto, and Tetsuya Harada</i>	

User Experience in Virtual, Augmented and Mixed Reality

Analysis of Differences in the Manner to Move Object in Real Space and Virtual Space Using Haptic Device for Two Fingers and HMD	291
<i>Yuki Aoki, Yuki Tasaka, Junji Odaka, Sakae Yamamoto, Makoto Sato, Takehiko Yamaguchi, and Tetsuya Harada</i>	
A Study of Size Effects of Overview Interfaces on User Performance in Virtual Environments.	302
<i>Meng-Xi Chen and Chien-Hsiung Chen</i>	
Text Input in Virtual Reality Using a Tracked Drawing Tablet	314
<i>Seyed Amir Ahmad Didehkhoshid, Siju Philip, Elaheh Samimi, and Robert J. Teather</i>	
Behavioral Indicators of Interactions Between Humans, Virtual Agent Characters and Virtual Avatars	330
<i>Tamara S. Griffith, Cali Fidopiastis, Patricia Bockelman-Morrow, and Joan Johnston</i>	
Perceived Speed, Frustration and Enjoyment of Interactive and Passive Loading Scenarios in Virtual Reality	343
<i>David Heidrich, Annika Wohlan, and Meike Schaller</i>	
Augmented Riding: Multimodal Applications of AR, VR, and MR to Enhance Safety for Motorcyclists and Bicyclists	356
<i>Caroline Kingsley, Elizabeth Thiry, Adrian Flowers, and Michael Jenkins</i>	
Virtual Environment Assessment for Tasks Based on Sense of Embodiment.	368
<i>Daiji Kobayashi, Yoshiki Ito, Ryo Nikaido, Hiroya Suzuki, and Tetsuya Harada</i>	
Camera-Based Selection with Cardboard Head-Mounted Displays	383
<i>Siqi Luo, Robert J. Teather, and Victoria McArthur</i>	
Improving the Visual Perception and Spatial Awareness of Downhill Winter Athletes with Augmented Reality	403
<i>Darren O'Neill, Mahmut Erdemli, Ali Arya, and Stephen Field</i>	
Desktop and Virtual-Reality Training Under Varying Degrees of Task Difficulty in a Complex Search-and-Shoot Scenario.	421
<i>Akash K. Rao, Sushil Chandra, and Varun Dutt</i>	
Computer-Based PTSD Assessment in VR Exposure Therapy.	440
<i>Leili Tavabi, Anna Poon, Albert Skip Rizzo, and Mohammad Soleymani</i>	

Text Entry in Virtual Reality: A Comparison of 2D and 3D
Keyboard Layouts 450
 Caglar Yildirim and Ethan Osborne

Author Index 461