

# Virtual Environments 2019

## ICAT - EGVE

29th International Conference on Artificial Reality and Telexistence  
24th Eurographics Symposium on Virtual Environments

The University of Tokyo - Hongo Campus, Japan  
September 11 – 13, 2019

### General Chair

Masahiko Inami, The University of Tokyo, Japan

### Program Co-Chairs

Yasuaki Kakehi, The University of Tokyo, Japan  
Atsushi Hiyama, The University of Tokyo, Japan

### Proceedings Production Editor

Dieter Fellner (TU Darmstadt & Fraunhofer IGD, Germany)

Sponsored by EUROGRAPHICS Association

Dieter W. Fellner, Werner Hansmann, Werner Purgathofer, François Sillion  
Series Editors

This work is subject to copyright.

All rights reserved, whether the whole or part of the material is concerned, specifically those of translation, reprinting, re-use of illustrations, broadcasting, reproduction by photocopying machines or similar means, and storage in data banks.

Copyright ©2019 by the Eurographics Association  
Postfach 2926, 38629 Goslar, Germany

Published by the Eurographics Association  
–Postfach 2926, 38629 Goslar, Germany–  
in cooperation with  
Institute of Computer Graphics & Knowledge Visualization at Graz University of Technology  
and  
Fraunhofer IGD (Fraunhofer Institute for Computer Graphics Research), Darmstadt

ISBN 978-3-03868-083-3 (Full Papers)  
ISBN 978-3-03868-097-0 (Posters and Demos)  
ISSN 1727-530X (Eurographics Symposium on Virtual Environments)

The electronic version of the proceedings is available from the Eurographics Digital Library at  
<https://diglib.eg.org>

## Table of Contents

Table of Contents .....	iii
Organizing Committee .....	vii
Author Index .....	ix
Author Index (Posters and Demos) .....	x
Keynotes and Invited Talks .....	xi
<b>Sensing and Interaction</b>	
Random-Forest-Based Initializer for Real-time Optimization-based 3D Motion Tracking Problems .....	1
<i>Jiawei Huang, Ryo Sugawara, Taku Komura, and Yoshifumi Kitamura</i>	
Automatic Labeling of Training Data by Vowel Recognition for Mouth Shape Recognition with Optical Sensors Embedded in Head-Mounted Display .....	9
<i>Fumihiko Nakamura, Katsuhiko Suzuki, Katsutoshi Masai, Yuta Itoh, Yuta Sugiura, and Maki Sugimoto</i>	
FaceDrive: Facial Expression Driven Operation to Control Virtual Supernumerary Robotic Arms .....	17
<i>Masaaki Fukuoka, Adrien Verhulst, Fumihiko Nakamura, Ryo Takizawa, Katsutoshi Masai, and Maki Sugimoto</i>	
<b>Tracking and Positioning</b>	
Evaluation of Embodied Agent Positioning and Moving Interfaces for an AR Virtual Guide .....	25
<i>Nattaon Techasarnitikul, Photchara Ratsamee, Jason Orlosky, Tomohiro Mashita, Yuki Uranishi, Kiyoshi Kiyokawa, and Haruo Takemura</i>	
Evaluation of Virtual Reality Tracking Systems Underwater .....	33
<i>Raphael Costa, Rongkai Guo, and John Quarles</i>	
Evaluation of Proxemics in Dynamic Interaction with a Mixed Reality Avatar Robot .....	37
<i>Jingxin Zhang, Omar Janeh, Nikolaos Katzakis, Dennis Krupke, and Frank Steinicke</i>	
<b>Perception and Human Augmentation</b>	
Rendering of Walking Sensation for a Sitting User by Lower Limb Motion Display .....	45
<i>Kentaro Yamaoka, Ren Koide, Tomohiro Amemiya, Michiteru Kitazaki, Vibol Yem, and Yasushi Ikei</i>	
Visuo-Haptic Interface to Augment Player's Perception in Multiplayer Ball Game .....	53
<i>Yuji Sano, Koya Sato, Ryoichiro Shiraiishi, Mai Otsuki, and Koichi Mizutani</i>	
Real Time Remapping of a Third Arm in Virtual Reality .....	57
<i>Adam Drogemuller, Adrien Verhulst, Benjamin Volmer, Bruce H. Thomas, Masahiko Inami, and Maki Sugimoto</i>	

## Table of Contents

### Simulation and Visualization

Virtual Ability Simulation: Applying Rotational Gain to the Leg to Increase Confidence During Physical Rehabilitation .....	65
<i>Tanvir Irfan Chowdhury, Sharif Mohammad Shahnewaz Ferdous, Tabitha Peck, and John Quarles</i>	
Interactive and Immersive Tools for Point Clouds in Archaeology .....	73
<i>Ronan Gagne, Quentin Petit, Jean-Baptiste Barreau, and Valérie Gouranton</i>	
Evaluation of a Mixed Reality based Method for Archaeological Excavation Support .....	81
<i>Ronan Gagne, Quentin Petit, Mai Otsuki, and Valérie Gouranton</i>	

### Design and Programming

Authoring AR Interaction by AR .....	89
<i>Flavien Lécuyer, Valérie Gouranton, Adrien Reuzeau, Ronan Gagne, and Bruno Arnaldi</i>	
Model and Tools for Integrating IoT into Mixed Reality Environments: Towards a Virtual-Real Seamless Continuum .....	97
<i>Jeremy Lacoche, Morgan Le Chenechal, Eric Villain, and Anthony Foulonneau</i>	
ReallifeEngine: A Mixed Reality-Based Visual Programming System for SmartHomes .....	105
<i>Ryohei Suzuki, Katsutoshi Masai, and Maki Sugimoto</i>	

## Table of Contents

### Posters

Production of Instructional Videos Using a Virtual Presentation Room on a Mobile Head-mounted Display . . . . .	1
<i>Kojiro Yano</i>	
Difference of the Sense of the Texture Between Visual and Touchable Cloth Object in VR Space . . . . .	3
<i>Yoshio Tsukuda and Masanao Koeda</i>	
Virtual Remote View System in Traffic Jam Using Smartphone Peer-to-peer Image Propagation . . . . .	5
<i>Shohei Miki, Hirotaka Itoh, and Kenji Funahashi</i>	
Wider IPD Makes People Perceive Their Body to be not so Large when Large Hands are Presented . . . . .	7
<i>Daisuke Mine, Nami Ogawa, Takuji Narumi, and Kazuhiko Yokosawa</i>	
Visual Search of Interactive Gaze in a Virtual Environment: Detecting Eye Contact is Faster than Gaze Averting . . . . .	9
<i>Kyosuke Yamamoto and Michiteru Kitazaki</i>	
Footstep Sound for Suppression of VR Sickness and Promotion of Sense of Agency . . . . .	11
<i>Reon Nashiki, Vibol Yem, Tomohiro Amemiya, and Yasushi Ikei</i>	
Generation of Walking Sensation by Upper Limb Motion . . . . .	13
<i>Gaku Sueta, Naoyuki Saka, Vibol Yem, Tomohiro Amemiya, Michiteru Kitazaki, Makoto Sato, and Yasushi Ikei</i>	
Airflow Presentation Method for Turning Motion Feedback in VR Environment . . . . .	15
<i>Yujin Suzuki, Vibol Yem, Koichi Hirota, Tomohiro Amemiya, Michiteru Kitazaki, and Yasushi Ikei</i>	
Preliminary Study on Surface Texture to Manipulate Perceived Softness of 3D Printed Objects . . . . .	17
<i>Motoki Miyoshi, Parinya Punpongsanon, Daisuke Iwai, and Kosuke Sato</i>	
Vehicle-Ride Sensation Sharing for Immersive Remote Collaboration with Vestibular Haptic Chair to reduce VR Sickness . . . . .	19
<i>Tsubasa Morita, Vibol Yem, Tomohiro Amemiya, and Yasushi Ikei</i>	
Expanding the Freedom of Eye-gaze Input Interface using Round-Trip Eye Movement under HMD Environment . . . . .	21
<i>Shogo Matsuno, Hironobu Sato, Kiyohiko Abe, and Minoru Ohyama</i>	
Visual Presentation For Sports Skill Learning in VR . . . . .	23
<i>Fumiya Miyashita, Tomohiro Amemiya, Michiteru Kitazaki, Keiko Kasamatsu, Vibol Yem, and Yasushi Ikei</i>	
Augmented Dodgeball AR Viewer for Spectators . . . . .	25
<i>Shota Azuma, Clara Hertzog, Sho Sakurai, Koichi Hirota, and Takuya Nojima</i>	
VR Sickness Reduction in Stereoscopic Video Streaming System 'TwinCam' for a Remote Experience . . . . .	27
<i>Ryunosuke Yagi, Toi Fujie, Tomohiro Amemiya, Michiteru Kitazaki, Vibol Yem, and Yasushi Ikei</i>	

## Table of Contents

System for Body Motion Capture While Moving in Large Area .....	29
<i>Yusuke Yuasa, Hideki Tamura, Vibol Yem, Tomohiro Amemiya, Michiteru Kitazaki, and Yasushi Ikei</i>	

### **Demo**

Narrowcasting for Stereoscopic Photospherical Cinemagraphy .....	31
<i>Michael Cohen, Takato Iida, and Rintarō Satō</i>	

## Organizing Committee

<b>General Chair</b>	Masahiko Inami, The University of Tokyo
<b>Program Chairs</b>	Yasuaki Kakehi, The University of Tokyo Atsushi Hiyama, The University of Tokyo
<b>Treasurer</b>	Yuta Sugiura, Keio University Daisuke Uriu, The University of Tokyo
<b>Award Chair</b>	Hiroyuki Shinoda, The University of Tokyo
<b>Demo Chairs</b>	Junichi Yamaoka, The University of Tokyo Shigeo Yoshida, The University of Tokyo Azumi Maekawa, The University of Tokyo
<b>Planning Chairs</b>	Maki Sugimoto, Keio University Bing-Yu Chen, National Taiwan University
<b>Venue Chairs</b>	Kazuma Aoyama, The University of Tokyo Shogo Fukushima, The University of Tokyo Sohei Wakisaka, The University of Tokyo Yasuko Otaki, The University of Tokyo Yasuyuki Inoue, The University of Tokyo Fumihiko Kato, The University of Tokyo
<b>Web Chairs</b>	Yuki Ban, The University of Tokyo Atsushi Izumihara, The University of Tokyo
<b>Publications Chairs</b>	Tomohiro Amemiya, The University of Tokyo Shunsuke Yoshimoto, The University of Tokyo
<b>Technical Tour Chairs</b>	Takefumi Ogawa, The University of Tokyo Takashi Miyaki, The University of Tokyo
<b>Banquet Chairs</b>	Hideaki Kuzuoka, The University of Tokyo Young Ah Seong, The University of Tokyo
<b>VRSJ AC General Chair</b>	Takeshi Naemura, The University of Tokyo
<b>VRSJ AC Program Chairs</b>	Shoichi Hasegawa, Tokyo Institute of Technology Kouta Minamizawa, Keio University Yoshihiro Watanabe, Tokyo Institute of Technology Takeo Hamada, The University of Tokyo

## Organizing Committee

<b>ICAT International Steering Committee</b>	Susumu Tachi, The University of Tokyo, Japan
	Kiyoshi Kiyokawa, NAIST, Japan
	Michitaka Hirose, The University of Tokyo, Japan
	Ming Ouhyoung, National Taiwan University, Taiwan
	Hyun Seung Yang, KAIST, Korea
	Mark Billingham, University South Australia, Australia
	Haruo Takemura, Osaka University, Japan
	Zhigeng Pan, Zhejiang University, China
	Tony Brooks, Aalborg University Esbjerg (AAUE), Denmark
	Yasushi Ikei, Tokyo Metropolitan University, Japan
	Hideo Saito, Keio University, Japan
	Sabine Coquillart, INRIA, France
	Yoshifumi Kitamura, Tohoku University, Japan
	Bruce H. Thomas, University South Australia, Australia
	Hirokazu Kato, NAIST, Japan
	Gabriel Zachmann, University of Bremen, Germany
	Carolina Cruz-Neira, University of Arkansas at Little Rock, USA
	Anthony Steed, University College London, UK
	Dirk Reiners University of Arkansas at Little Rock, USA
	Ross Smith, University of South Australia, Australia
Despina Michael-Grigoriou, Cyprus University of Technology, Cyprus	
<b>EGVE International Steering Committee</b>	Anthony Steed University College London, UK
	Sabine Coquillart, INRIA, France
	Dieter Schmalstieg, Graz University of Technology, Austria
	Yoshifumi Kitamura Tohoku University, Japan



## Author Index

Amemiya, Tomohiro	45	Mizutani, Koichi	53
Arnaldi, Bruno	89	Nakamura, Fumihiko	9, 17
Barreau, Jean-Baptiste	73	Orlosky, Jason	25
Chenechal, Morgan Le	97	Otsuki, Mai	53, 81
Chowdhury, Tanvir Irfan	65	Peck, Tabitha	65
Costa, Raphael	33	Petit, Quentin	73, 81
Drogemuller, Adam	57	Quarles, John	33, 65
Ferdous, Sharif Mohammad Shahnewaz	65	Ratsamee, Photchara	25
Foulonneau, Anthony	97	Reuzeau, Adrien	89
Fukuoka, Masaaki	17	Sano, Yuji	53
Gaugne, Ronan	73, 81, 89	Sato, Koya	53
Gouranton, Valérie	73, 81, 89	Shiraishi, Ryoichiro	53
Guo, Rongkai	33	Steinicke, Frank	37
Huang, Jiawei	1	Sugawara, Ryo	1
Ikei, Yasushi	45	Sugimoto, Maki	9, 17, 57, 105
Inami, Masahiko	57	Sugiura, Yuta	9
Itoh, Yuta	9	Suzuki, Katsuhiko	9
Janeh, Omar	37	Suzuki, Ryohei	105
Katzakis, Nikolaos	37	Takemura, Haruo	25
Kitamura, Yoshifumi	1	Takizawa, Ryo	17
Kitazaki, Michiteru	45	Techasartikul, Nattaon	25
Kiyokawa, Kiyoshi	25	Thomas, Bruce H.	57
Koide, Ren	45	Uranishi, Yuki	25
Komura, Taku	1	Verhulst, Adrien	17, 57
Krupke, Dennis	37	Villain, Eric	97
Lacoste, Jeremy	97	Volmer, Benjamin	57
Lécuyer, Flavien	89	Yamaoka, Kentaro	45
Masai, Katsutoshi	9, 17, 105	Yem, Vibol	45
Mashita, Tomohiro	25	Zhang, Jingxin	37

### Author Index (Posters and Demos)

Abe, Kiyohiko	21	Nashiki, Reon	11
Amemiya, Tomohiro	11, 13, 15, 19, 23, 27, 29	Nojima, Takuya	25
Azuma, Shota	25	Ogawa, Nami	7
Cohen, Michael	31	Ohyama, Minoru	21
Fujie, Toi	27	Punpongsanon, Parinya	17
Funahashi, Kenji	5	Saka, Naoyuki	13
Hertzog, Clara	25	Sakurai, Sho	25
Hirota, Koichi	15, 25	Sato, Hironobu	21
Iida, Takato	31	Sato, Kosuke	17
Ikei, Yasushi	11, 13, 15, 19, 23, 27, 29	Sato, Makoto	13
Itoh, Hirotaka	5	Satō, Rintarō	31
Iwai, Daisuke	17	Sueta, Gaku	13
Kasamatsu, Keiko	23	Suzuki, Yujin	15
Kitazaki, Michiteru	9, 13, 15, 23, 27, 29	Tamura, Hideki	29
Koeda, Masanao	3	Tsukuda, Yoshio	3
Matsuno, Shogo	21	Yagi, Ryunosuke	27
Miki, Shohei	5	Yamamoto, Kyosuke	9
Mine, Daisuke	7	Yano, Kojiro	1
Miyashita, Fumiya	23	Yem, Vibol	11, 13, 15, 19, 23, 27, 29
Miyoshi, Motoki	17	Yokosawa, Kazuhiko	7
Morita, Tsubasa	19	Yuasa, Yusuke	29
Narumi, Takuji	7		

## Keynote

### Living in Dream

*Yuji Ikegaya*

Graduate School of Pharmaceutical Sciences, The University of Tokyo  
Professor

### Short Biography

1998 PhD. Graduate School of Pharmaceutical Sciences, the University of Tokyo, Japan

1998-2006 Assistant Professor at Graduate School of Pharmaceutical Sciences, the University of Tokyo, Japan

2002-2005 Postdoctoral Researcher at Department of Biology, Columbia University, USA

2006-2007 Lecturer at Graduate School of Pharmaceutical Sciences, the University of Tokyo, Japan

2007-2014 Associate Professor at Graduate School of Pharmaceutical Sciences, the University of Tokyo, Japan

2014-present Professor at Graduate School of Pharmaceutical Sciences, the University of Tokyo, Japan

## Keynote

### **Creative a Conceptual Design Thinking with three Design disciplines: Product, Interaction, and Service**

*Chien-Hsu Chen*

National Cheng Kung University  
Professor

#### **Short Biography**

Chien-Hsu Chen received the B.S. degree in industrial design from the National Cheng Kung University (NCKU), Taiwan, in 1987, and the master and Ph.D. degrees in computer & information science from Syracuse University, USA, industrial engineering from University of Texas at Arlington, USA, in 1992 and 1996, respectively. In 1996, he joined the Department of Industrial Design, Chang Kung University, as a Lecturer, and in 1997 became an assistant professor at Craft & Design Department of National Taiwan University of Arts. Since August 1998, he has been with the Department of Industrial Design, NCKU, where he was an assistant Professor, became an associate Professor in 2004, and a Professor in 2014. His research interests include ergonomics and interaction design, augmented reality application. He is a Life Member of the Ergonomic Society of Taiwan (EST), and the Taiwan Institute of Kansei (TIK). He was the Chairman of Industrial Design department at National Cheng Kung University from 2010 to 2013. From February 2015 to July 2016, he was the business dept. deputy of Research and Services Headquarters(RSH) at NCKU in Taiwan. On August 2016, he has in sabbatical leave for one year and he is the visiting researcher of Research Center for Advanced Science and Technology at University of Tokyo in Japan. Since August 2017, he is the Director general of Technology Transfer & Business Incubation Center(TTBIC) at NCKU in Taiwan.

## Keynote

### How Niantic AR Unites People and Reality

*Masashi Kawashima*

Niantic, Inc.

Director of Asia Pacific operations

#### **Short Biography**

Masashi Kawashima is Asia Pacific Director of Niantic, Inc. Niantic initially started as a “startup” within Google, and spun out from Google in October 2015. He joined Niantic Labs in 2013 as a UX/Visual designer and designed Ingress’ visual and user experiences. Masa also contributed to the launch of a new ground-breaking project for mobile devices called “Pokémon GO”, in which players can look for and capture Pokemon in the real world. After leaving Waseda University, he went to the United States in 2000. Joined Google in 2007 after working in Los Angeles and working in design production. He oversees the web design team in the Asia-Pacific, and for the first time in Japan, he designs “Doodle” in the world. At the time of the Great East Japan Earthquake, the Crisis Response Web Team was launched. In 2011, he moved to Google headquarters in the United States to manage the global team of consumer products web design.

## Invited Talk

### Forty Years of Telexistence — From Concept to TELESAR VI

*Susumu Tachi*

The University of Tokyo  
Professor Emeritus

#### **Abstract**

Telexistence is a human-empowerment concept that enables a human in one location to virtually exist in another location and to act freely there. The term also refers to the system of science and technology that enables realization of the concept. The concept was originally proposed by the author in 1980, and its feasibility has been demonstrated through the construction of alter-ego robot systems such as TELESAR, TELESAR V, and TELESAR VI, which were developed under the national research and development projects “MITI Advanced Robot Technology in Hazardous Environments,” the “CREST Haptic Telexistence Project,” and the “ACCEL Embodied Media Project,” respectively. Mutual telexistence systems, such as TELESAR II & IV, capable of generating the sensation of being in a remote place using a combination of alter-ego robotics and retro-reflective projection technology (RPT), have been developed, and the feasibility of mutual telexistence has been demonstrated. Forty years of telexistence development are historically reviewed in this keynote paper.

#### **Short Biography**

Susumu Tachi is Professor Emeritus at The University of Tokyo, where he currently leads several research projects on telexistence, virtual reality, and haptics, including ACCEL Embodied Media Project at Tachi Laboratory, Institute of Gerontology. He is the founding president of the Virtual Reality Society of Japan.

One of his earliest scientific achievements, shortly after obtaining his Ph.D. from The University of Tokyo in 1973, was the invention of Guide Dog Robot, an intelligent mobile robot system for the blind. It was the first of its kind and came to be known as MELDOG.

In 1980, Dr. Tachi invented the concept of telexistence, which enables a highly realistic sensation of existence in a remote place without any actual travel, and has been working on its realization ever since.

Other achievements include Haptic Primary Colors, Optical Camouflage, and autostereoscopic VR displays such as TWISTER, Repro3D, and HaptoMIRAGE. He was the recipient of the 2007 IEEE Virtual Reality Career Award.

## Invited Talk

### VR Center and Dawn of Service VR Research

*Michitaka Hirose*

The University of Tokyo  
Professor

#### **Short Biography**

Michitaka Hirose is a professor of human interface and systems engineering in the Graduate School of Information Science and Technology, University of Tokyo. He was born in 1954 in Kamakura, Japan. He received BE, ME, PhD in Mechanical Engineering from the University of Tokyo, in 1977, 1979, 1982, respectively. Since then, he has been in several positions such as Associate Professor and Professor at the University of Tokyo.

His research interests cover Multimedia, Human Interface and Virtual Reality. He is known as a pioneer of Japanese Virtual Reality research. He served as project leaders of many national R&D projects such as “Digital Museum”, “Digital Public Art” and “Multimedia Virtual Laboratory”.

He was awarded with various prizes such as IEEE VGTC 2015 Virtual Reality Career Award, Tokyo Techno-Forum Gold Medal Prize and Okawa Publishing Prize etc.