

# **13<sup>th</sup> International Symposium on Visual Computing (ISVC'18)**

**November 19-21, 2018, Las Vegas, Nevada, USA**



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**Registration Desk Hours:** Monday – Wednesday 8AM – 4:30PM



# Monday (morning), November 19<sup>th</sup>

8:50-9:00	Welcome to ISVC'18 – George Bebis		
9:00-10:00	Keynote: <a href="#">Octavia Camps, Northwestern University, USA</a> (Lotus Ballroom 1)		
	Parallel Sessions		
10:10-11:50	<b>ST: Computational Bioimaging</b> Chair: <b>George Bebis</b> (Lotus Ballroom 1)		<b>Computer Graphics</b> Chair: <b>Alireza Tavakkoli</b> (Galleria D)
	10:10	Skin Cancer Segmentation Using a Unified Markov Random Field <i>Omran Salih and Serestina Viriri</i>	PSO-based Newton-like Method and Iteration Processes in the Generation of Artistic Patterns <i>Ireneusz Gosciniaik and Krzysztof Gdawiec</i>
	10:30	Automatic Registration of Serial Cerebral Angiography: A Comparative Review <i>Alice Tang, Zhiyuan Zhang and Fabien Scalzo</i>	Biomimetic Perception Learning for Human Sensorimotor Control <i>Masaki Nakada, Honglin Chen and Demetri Terzopoulos</i>
10:50-11:10	Coffee Break		
	11:10	Heart Modeling by Convexity Preserving Segmentation and Convex Shape Decomposition <i>Xue Shi, Lijun Tang, Shaoxiang Zhang and Chunming Li</i>	Porous Structure Design in Tissue Engineering Using Anisotropic Radial Basis Functions <i>Ye Guo, Ke Liu and Zeyun Yu</i>
	11:30	Skull Stripping using Confidence Segmentation Convolution Neural Network <i>Kaiyuan Chen, Jingyue Shen and Fabien Scalzo</i>	An Evaluation of Smoothing and Remeshing Techniques to Represent the Evolution of Real-World Phenomena <i>José Duarte, Paulo Dias and José Moreira</i>
	Parallel Sessions		
10:10-11:50	<b>ST: Intelligent Environments: Algorithms and Applications</b> Chair: <b>Mircea Nicolescu</b> (Galleria E)		
	10:10	Accurate and Efficient Non-Parametric Background Detection for Video Surveillance <i>William Porr, James Easton, Alireza Tavakkoli, Donald Loffredo and Sean Simmons</i>	
	10:30	A Low-Power Neuromorphic System for Real-Time Visual Activity Recognition <i>Deepak Khosla, Ryan Uhlenbrock and Yang Chen</i>	
10:50-11:10	Coffee Break		
	11:10	Robust Incremental Hidden Conditional Random Fields for Human Action Recognition <i>Michalis Vrigkas, Ermioni Mastora, Christophoros Nikou and Ioannis Kakadiaris</i>	
	11:30	Video-based human action recognition using kernel relevance analysis <i>Jorge Fernández Ramírez, Andrés Álvarez Meza and Álvaro Orozco Gutiérrez</i>	
11:50-1:30	Lunch (on your own)		

# Monday (afternoon), November 19<sup>th</sup>

1:30-2:30	Keynote: <a href="#">Adam Bargteil, University of Maryland, Baltimore County, USA</a> (Lotus Ballroom 1)	
	Parallel Sessions	
2:40-4:40	<b>Pattern Recognition</b> Chair: <b>Christophoros Nikou</b> (Lotus Ballroom 1)	<b>Virtual Reality I</b> Chair: <b>Alireza Tavakkoli</b> (Galleria D)
	<b>2:40</b> Rotation Symmetry Object Classification using Structure Constrained Convolutional Neural Network <i>Seunghwa Yu and Seungkyu Lee</i>	Training in Virtual Environments for Hybrid Power Plants <i>Víctor H. Andaluz, Max G. Chiluisa and Rubén D. Mullo</i>
	<b>3:00</b> A Hough Space Feature for Vehicle Detection <i>Chunling Tu and Shengzhi Du</i>	Visualizing Viewpoint Movement on Driving by Space Information Rendering <i>Satoru Morita</i>
3:20-3:40	Coffee Break	
	<b>3:40</b> Gender Classification Based on Facial Shape and Texture Features <i>Mayibongwe Bayana, Serestina Viriri and Raphael Angulu</i>	Virtual Reality System for Children Lower Limb Strengthening with the use of Electromyographic Sensors <i>Eddie Galarza, Pablo Zambrano, Victoria Lopez, Marco Pilatasig, Eddie D. Galarza, Jorge Buele and John Espinoza</i>
	<b>4:00</b> Authentication-based on Biomechanics of Finger Movements captured using Optical Motion-Capture <i>Brittany Lewis, Christopher J. Nycz, Gregory S. Fischer and Krishna K. Venkatasubramanian</i>	A Comparative Study of Virtual UI for Risk Assessment and Evaluation <i>Naila Bushra, Daniel W. Carruth and Shuchisnigdha Deb</i>
	<b>4:20</b> Specific Document Sign Location Detection Based on Point Matching and Clustering <i>Xiong Huaixin</i>	Sensory Fusion and Intent Recognition for Accurate Gesture Recognition in Virtual Environments <i>Kevin Clark, Sean Simmons, Alireza Tavakkoli and Donald Loffredo</i>
	Parallel Sessions	
2:40-4:20	<b>Deep Learning I</b> Chairs: <b>Fabien Scalzo</b> (Galleria E)	
	<b>2:40</b> Accuracy of a Driver-Assistance System in a Collision Scenario <i>Waqar Khan and Reinhard Klette</i>	
	<b>3:00</b> Classify broiler viscera using an iterative approach on noisy labelled training data <i>Anders Jørgensen, Jens Fagertun and Thomas B. Moeslund</i>	
3:20-3:40	Coffee Break	
	<b>3:40</b> Instance-level Object Recognition using Deep Temporal Coherence <i>Miguel Lagunes-Fortiz, Dima Damen and Walterio Mayol-Cuevas</i>	
	<b>4:00</b> DUPL-VR: Deep Unsupervised Progressive Learning for Vehicle Re-Identification <i>Raja Muhammad Saad Bashir, Muhammad Shahzad and Muhammad Moazam Fraz</i>	
6:30-8:30	Welcome Reception (Lotus Ballroom 2)	

# Tuesday (morning), November 20<sup>th</sup>

9:00-10:00	Keynote: <a href="#">Sylvain Paris, Adobe Research, USA</a> (Lotus Ballroom 1)		
	Parallel Sessions		
10:10-12:10	<b>Motion and Tracking</b> Chair: <b>Mircea Nicolescu</b> (Lotus Ballroom 1)		<b>Visualization</b> Chairs: <b>Xi-Kui Miao</b> (Galleria D)
	10:10	Particle Filter Based Tracking and Mapping <i>Nils Höhner, Anna Katharina Hebborn and Stefan Müller</i>	Visualization of Parameter Sensitivity of 2D Time-Dependent Flow <i>Karsten Hanser, Ole Klein, Bastian Rieck, Bettina Wiebe, Tobias Selz, Marian Piatkowski, Toni Sagrista, Boyan Zheng, Maria Lukacova, George Craig, Heike Leitte and Filip Sadlo</i>
	10:30	Multi-Branch Siamese Networks with Online Selection for Object Tracking <i>Zhenxi Li, Guillaume-Alexandre Bilodeau and Wassim Bouachir</i>	Non-stationary generalized Wishart process for enhancing resolution over diffusion tensor fields <i>Jhon Fredy Cuellar Fierro, Hernán Darío Vargas Cardona, Andrés Marino Álvarez Meza, Álvaro Ángel Orozco Gutiérrez and Mauricio Alexander Álvarez López</i>
10:50-11:10	Coffee Break		
	11:10	Deep Convolutional Correlation Filters for Visual Tracking by Detection <i>Yong Wang, Robert Laganieri, Daniel Laroche, Ali Osman Ors, Xiaoyin Xu and Changyun Zhu</i>	Reduced-reference image quality assessment based on improved local binary pattern <i>Xi-Kui Miao, Dah-Jye Lee, Xiang-Zheng Cheng and Xiao-Yu Yang</i>
	11:30	A Mumford Shah Style Unified Framework for Layering: Pitfalls and Solutions <i>Fareed Jafri, Anthony Joseph Yezzi and Martin Mueller</i>	Web system for visualization of weather data of the hydrometeorological network of Tungurahua, Ecuador <i>Fernando A. Chicaiza, Jaime Santana, Victor H. Andaluz and Patrick Alexander Reuter</i>
	11:50	The bird gets caught by the WORM: tracking multiple deformable objects in noisy environments using Weight ORdered Logic Maps <i>Debajyoti Karmaker, Ingo Schiffner, Michael Wilson and Mandyam V. Srinivasan</i>	Analysis and Visualization of Sports Performance Anxiety in Tennis Matches <i>Shiraj Pokharel and Ying Zhu</i>
	Parallel Sessions		
10:10-12:10	<b>Object Detection and Recognition</b> Chair: <b>Yoshinori Kuno</b> (Galleria E)		
	10:10	Detailed sentence generation architecture for image semantics description <i>Imran Khurram, Muhammad Moazam Fraz and Muhammad Shahzad</i>	
	10:30	Pupil Localization Using Geodesic Distance <i>Radovan Fusek</i>	
10:50-11:10	Coffee Break		
	11:10	Parallel Curves Detection Using Multi-Agent System <i>Shengzhi Du and Chunling Tu</i>	
	11:30	Can Deep Learning Learn the Principle of Closed Contour Detection? <i>Xinhua Zhang, Yijing Watkins and Garrett Kenyon</i>	
12:10-1:30	Lunch (on your own)		

## Tuesday (afternoon), November 20<sup>th</sup>

Parallel Sessions			
<b>1:30-3:30</b>	<b>Deep Learning II</b> Chair: <b>Robert Laganiere</b> (Lotus Ballroom 1)		<b>Applications I</b> Chair: <b>Kristian Sandberg</b> (Galleria D)
	<b>1:30</b>	DensSiam: End-to-End Densely-Siamese Network with Self-Attention Model for Object Tracking <i>Mohamed Abdelpakey, Mohamed Shehata and Mostafa Mohamed</i>	Vision-Depth Landmarks and Inertial Fusion for Navigation in Degraded Visual Environments <i>Shehryar Khattak, Christos Papachristos and Kostas Alexis</i>
	<b>1:50</b>	Convolutional Adaptive Particle Filter with Multiple Models for Visual Tracking <i>Reza Jalil Mozhdzhi, Yevgeniy Reznichenko, Abubakar Siddique and Henry Medeiros</i>	Efficient Nearest Neighbors Search for Large-Scale Landmark Recognition <i>Federico Magliani, Tomaso Fontanini and Andrea Prati</i>
	<b>2:10</b>	Scale-aware RPN for Vehicle Detection <i>Lu Ding, Yong Wang, Robert Laganiere, Xinbin Luo and Shan Fu</i>	Patient's Body Motion Study using Multimodal RGBDT Videos <i>M. A. Haque, S. S. Kjeldsen, F. G. Arguissain, Iris Brunner, K. Nasrollahi, O. Kæseler Andersen, J. F. Nielsen, T. B. Moeslund and A. Jørgensen</i>
<b>2:30-2:50</b>	Coffee Break		
	<b>2:50</b>	Object Detection to Assist Visually Impaired People: A Deep Neural Network Adventure <i>Fereshteh S. Bashiri, Eric LaRose, Jonathan C. Badger, Roshan M. D'Souza, Zeyun Yu and Peggy Peissig</i>	Marker based Thermal-Inertial Localization for Aerial Robots in Obscurant Filled Environments <i>Shehryar Khattak, Christos Papachristos and Kostas Alexis</i>
	<b>3:10</b>	Large Scale Application Response Time Measurement using Image Recognition and Deep Learning <i>Lan Vu, Uday Kurkure, Hari Sivaraman and Aravind Bappanadu</i>	Shape-based Smoothing of Binary Digital Objects Using Signed Distance Transform <i>Xiaoliu Zhang, Cheng Chen, Gregory Chang and Punam Saha</i>
Parallel Sessions			
<b>1:30-3:30</b>	<b>Segmentation</b> Chair: <b>Moujahdi Chouaib</b> (Galleria E)		
	<b>1:30</b>	Patch-based potentials for interactive contour extraction <i>Thoraya Ben Chattah, Sébastien Bogleux, Olivier Lézoray and Atef Hamouda</i>	
	<b>1:50</b>	A New Algorithm for Local Blur-Scale Computation and Edge Detection <i>Indranil Guha and Punam Saha</i>	
	<b>2:10</b>	Semantic Segmentation by Integrating Classifiers for Different Difficulty Levels <i>Daisuke Matsuzuki and Kazuhiro Hotta</i>	
<b>2:30-2:50</b>	Coffee Break		
<b>6:00-9:00</b>	Banquet Dinner Keynote: <a href="#">Narendra Ahuja, University of Illinois at Urbana-Champaign, USA</a> (Lotus Ballrooms 2 & 3)		

## Wednesday (morning), November 21<sup>st</sup>

<b>9:00-10:00</b>	Keynote: <a href="#">Zachary Wartell, University of North Carolina at Charlotte, USA</a> (Lotus Ballroom 1)		
	<b>Parallel Sessions</b>		
<b>9:40-11:50</b>	<b>Applications II</b> Chair: <b>Punam Saha</b> (Lotus Ballroom 1)		<b>Virtual Reality II</b> Chairs: <b>Moujahdi Chouaib</b> (Galleria D)
	<b>10:10</b>	Fast Image Dehazing Methods for Real-Time Video Processing <i>Yang Chen and Deepak Khosla</i>	Augmented Reality System for Training and Assistance in the Management of Equipment and Industrial Instruments <i>Edison Chicaiza, Edgar De la Cruz and Víctor H. Andaluz</i>
	<b>10:30</b>	GPU Accelerated Non-Parametric Background Subtraction <i>William Porr, James Easton, Alireza Tavakkoli, Donald Loffredo and Sean Simmons</i>	Alternative Treatment for Spider Phobia through Virtual Reality Environments <i>Victor H. Andaluz and Joseph Armas</i>
<b>10:50-11:10</b>	<i>Coffee Break</i>		
	<b>11:10</b>	Budget-constrained Online Video Summarisation of Egocentric Video Using Control Charts <i>Paria Yousefi, Clare Matthews and Ludmila Kuncheva</i>	The skyline as a marker for augmented reality in urban context <i>Mehdi Ayadi, Leo Valque, Mihaela Scuturici, Chokri Ben Amar and Serge Miguet</i>
	<b>11:30</b>	p-Laplacian regularization of signals on directed graphs <i>Zeina Abu Aisheh, Sébastien Bogleux and Olivier Lézoray</i>	Oil Processes VR Training <i>Víctor H. Andaluz, Washington X. Quevedo, Jorge Mora-Aguilar, Daniel Castillo-Carrion, Roberto J. Miranda and María G. Pérez</i>
	<b>11:50</b>	A Dense-Depth Representation for VLAD descriptors in Content-Based Image Retrieval <i>Federico Magliani, Tomaso Fontanini and Andrea Prati</i>	
<b>11:50-1:30</b>	<i>Lunch (on your own)</i>		

## Wednesday (afternoon), November 21<sup>st</sup>

1:30-2:30	Keynote: <a href="#">Renato Pajarola, University of Zurich, Switzerland</a> (Lotus Ballroom 1)	
	Parallel Sessions	
2:40-4:40	<b>ST: Intelligent Transportation Systems</b> Chair: <b>Brendan Morris</b> (Lotus Ballroom 1)	
	2:40	Multiple Object Tracking in Urban Traffic Scenes with a Multiclass Object Detector <i>Hui-Lee Ooi, Guillaume-Alexandre Bilodeau, Nicolas Saunier and David-Alexandre Beaupre</i>
	3:00	Autonomous Bus Boarding Robotic Wheelchair using Bidirectional Sensing Systems <i>Shamim Al Mamun, Hisato Fukuda, Antony Lam, Yoshinori Kobayashi and Yoshinori Kuno</i>
3:20-3:40	Coffee Break	
	3:40	Traffic Flow Classification Using Traffic Cameras <i>Mohammad Shokrolah Shirazi and Brendan Morris</i>
	4:00	Road User Abnormal Trajectory Detection using a Deep Autoencoder <i>Pankaj Roy and Guillaume-Alexandre Bilodeau</i>



## KEYNOTE TALK

*Monday, November 19, 2018  
9:00 am – 10:00 am (Lotus Ballroom 1)*

### Dynamics-based Invariants for Video Understanding

*Octavia I. Camps  
Northeastern University*

#### Abstract

The power of **geometric invariants** to provide solutions to computer vision problems has been recognized for a long time. On the other hand, **dynamics-based invariants** are often overlooked. Yet, visual data come in streams: videos are temporal sequences of frames, images are ordered sequences of rows of pixels and contours are chained sequences of edges. In this talk, I will discuss the key role that systems theory can play in timely extracting and exploiting dynamics-based invariants to capture actionable information that is very sparsely encoded in high dimensional data streams. The central theme of this approach is the use of dynamical models, and their associated invariants, as an information-encoding paradigm. We will show that embedding problems in the conceptual world of dynamical systems makes available a rich, extremely powerful resource base, leading to robust solutions, or, in cases where the underlying problem is intrinsically hard, to computationally tractable approximations with sub optimality certificates. We will illustrate these ideas in the context of several practical applications: crowd-sourcing video, activity recognition, human re-identification and video prediction.



**Speaker Bio-Sketch:** Octavia Camps received a B.S. degree in computer science and a B.S. degree in electrical engineering from the Universidad de la Republica (Uruguay), and a M.S. and a Ph.D. degree in electrical engineering from the University of Washington. Since 2006, she is a Professor in the Electrical and Computer Engineering Department at Northeastern University. From 1991 to 2006 she was a faculty of Electrical Engineering and of Computer Science and Engineering at The Pennsylvania State University. Prof. Camps was a visiting researcher at the Computer Science Department at Boston University during Spring 2013 and in 2000, she was a visiting faculty at the California Institute of Technology and at the University of Southern California. She is an associate editor of Computer Vision and Image Understanding (CVIU). Her main research interests include

robust computer vision, image processing, and machine learning.

## KEYNOTE TALK

*Monday, November 19, 2018  
1:30 pm – 2:30 pm (Lotus Ballroom 1)*

### **Computer Animation: Past, Present, and Future**

*Adam Bargteil  
University of Maryland, Baltimore County*

#### **Abstract**

Computer animation has made enormous progress over the last thirty years—from the genesis effect in *The Wrath of Khan* to the epic battle sequences of *Avengers: Infinity War*. Today, special effects are almost universally achieved through computer animation and we have the technology to create almost any effect we can imagine. Over the next thirty years we will see a similar transformation, this time in the realm of interactive animation and mixed reality. In this talk, I will chronicle the history of computer animation in research and in practice, take stock of where we are today, and look ahead to an exciting future.



**Speaker Bio-Sketch:** Adam Bargteil an assistant professor in the Department of Computer Science and Electrical Engineering at the University of Maryland, Baltimore County. His primary research interests are in computer graphics and animations, particularly physics-based animation. He completed his Ph.D. in computer science at the University of California at Berkeley, where I worked in the Berkeley Computer Animation & Modeling group. He then spent two years as a postdoctoral fellow in the City of Bridges working in the Graphics Lab at Carnegie Mellon University. Before returning home to Maryland, he was an assistant professor in the School of Computing at the University of Utah.

## KEYNOTE TALK

*Tuesday, November 20, 2018  
9:00 am – 10:00 am (Lotus Ballroom 1)*

### **Photography Made Easy**

*Sylvain Paris  
Adobe*

#### **Abstract**

With digital cameras and smartphones, taking a picture has become effortless and easy. Autofocus and autoexposure ensure that all photos are sharp and properly exposed. However, this is not sufficient to get great photos. Most pictures need to be retouched to become aesthetically pleasing. This step still requires a great deal of expertise and a lot of time when done with existing tools. Over the years, I have dedicated a large part of my research to improving this situation. In this talk, I will present a few recent results where we use existing photos by artists as models to make ordinary pictures look better.



**Speaker Bio-Sketch:** Sylvain Paris is a researcher at Adobe Research in Cambridge Massachusetts. Before that, he was a post-doc at MIT with Frédo Durand and a student at INRIA in Grenoble with François Sillion. His interests cover computational photography and image processing. He has done several contributions to the field of photo and video editing, the goal being to help novices and experts create better pictures and videos. Some of the technology that he has invented is now available in commercial software such as Photoshop and Lightroom.

# BANQUET KEYNOTE TALK

*Tuesday, November 20, 2018  
7:30 pm – 8:30 pm (Lotus Ballroom 1)*

## The Four Decades of Computer Vision

*Narendra Ahuja*

*Beckman Institute, University of Illinois at Urbana-Champaign &  
ITRA, Media Lab Asia, Ministry of Electronics and Information Technology*

### Abstract

We will review selected themes and results that have characterized computer vision research over the past four decades. Emphases have been changing not only with respect to the areas and problems addressed, but also in relatively basic objectives and approaches taken. Starting with the early days of image processing, we will summarize activities involving image analysis, remote and short range images, video analysis, 3D estimation, computer vs human vision, role of image synthesis, perception-action-loop and robotics, active vision, physics based vision, computational photography, object recognition, model vs data driven methods, visual learning, and vision in IoT. This range of major activities reinforces the view that computer vision is an extremely diverse and challenging field. New areas and problems have been emerging faster than they can be solved, which in part explains the dramatic and continuing growth of the field.



**Speaker Bio-Sketch:** Narendra Ahuja is Research Professor in the Dept. of Electrical and Computer Engineering, Beckman Institute, and Coordinated Science Laboratory, University of Illinois at Urbana-Champaign (<http://vision.ai.illinois.edu/ahuja.html>) and the Founding Director of Information Technology Research Academy (<http://itra.medialabasia.in>), Government of India. He received B.E. with honors in electronics engineering from BITS, Pilani, India, M.E. with distinction in electrical communication engineering from IISc, Bangalore, India, and Ph.D. in computer science from University of Maryland, College Park, USA. In 1979, he joined UIUC where he was Donald Biggar Willet Professor of Engineering until 2012. During 1999-2002, he served as the Founding Director of International Institute of Information Technology, Hyderabad (IIITH), first of now about 24 IIITs. He

has co-authored three books and over 400 papers in journals and conferences, and received 4 patents. He has supervised research of about 50 PhD, 15 MS and 100 Undergrad students and 10 Postdocs. His algorithms/prototype systems have been used by about a dozen companies/organizations, including industrial systems at General Electric, Westinghouse, Lockheed and Honeywell. He is a fellow of IEEE, American Association for Artificial Intelligence, International Association for Pattern Recognition, Association for Computing Machinery, American Association for the Advancement of Science, and International Society for Optical Engineering. He received the Emanuel R. Piore award of the IEEE, and the Technology Achievement Award of the International Society for Optical Engineering, and TA Stewart-Dyer/Frederick Harvey Trevithick Prize of the Institution of Mechanical Engineers, and was conferred an Honorary Doctorate from York University, England (2018). With his students, he shared Best Paper Awards given by: International Conference on Pattern Recognition (Piero Zamperoni Award), Symposium on Eye Tracking Research and Applications, First IEEE International Workshop on Computer Vision in Sports, International Conference on Pattern Recognition, and IEEE Transaction on Multimedia.

## KEYNOTE TALK

Wednesday, November 21, 2018  
9:00 am – 10:00 am (Lotus Ballroom 1)

### Interaction in Multi-Scale Environments on Virtual Reality Systems

Zachary Wartell  
University of North Carolina at Charlotte

#### Abstract

The terms “scale”, “zoom” and “multi-scale” have subtly but significantly different definitions across zoomable 2D user interfaces (UI) and 3D user interfaces. Further, 3D UI’s can execute on Window-Icon-Menu-Pointer desktop systems or execute on systems using a combination of visually coupled display (typically implemented via head-tracking), true 3D display (typically implemented via binocular stereoscopy), and/or 6 degree-of-freedom (6DOF) direct manipulation. (The abbreviation VC-3D-DM distinguishes such systems). For simplicity, define a virtual reality (VR) 3D UI as an UI on a system with one or more of the VC-3D-DM properties and define a non-VR 3D UI as UI on a system lacking all VC-3D-DM properties. Perceptual differences between 2D zoomable UIs, and VR and non-VR 3D UIs complicate transferring concepts and theory as well as porting interaction techniques between these systems. This is particularly important in *multi-scale* virtual environments, which have geometric details at multiple orders of magnitude in size all of which are relevant to the application. Zoom view maneuvers are fundamental to such environments. I will briefly present preliminary results from two geometric theorems regarding the “perspective equivalence” of the two most common types of zooms in 3D UIs: “scale” zooms and “translation” zooms (called *dolly*ing in cinematography). I will briefly discuss how these theoretical results relate to well-known empirical experience that shows that VR 3D UIs for multi-scale environments require treating scale as a separate 7<sup>th</sup> DOF within the view model. Finally, I will present experimental evaluations of several ways to semi-automate the adjustment of this 7<sup>th</sup> DOF during travel in multi-scale VEs in two VR display systems.



**Speaker Bio-Sketch:** Zachary Wartell is an Associate Professor in the Department of Computer Science in the College of Computing and Informatics at the University of North Carolina at Charlotte (UNC Charlotte). He is the Co-Director of The Charlotte Visualization Center. Dr. Wartell received his Ph.D. from the College of Computing at the Georgia Institute of Technology in 2001. He worked for several years at the Human Interface Technology Center at NCR. He joined UNC Charlotte in 2005. Dr. Wartell’s research interests include 3D visualization and 3D graphics and advanced user interfaces including virtual and mixed reality interfaces and multi-touch displays. A common thread through his research has been 2D and 3D geo-spatial interactive visualizations and stereoscopic display systems. His recent collaborative projects have broadened to visual analytics in particular for power distribution systems. Dr. Wartell has served the IEEE VR conferences in various capacities including Local Arrangements co-Chair in 2007 and General co-Chair in 2016. His work has been published in IEEE 3DUI, IEEE VR, ACM SUI and IEEE TVCG. His research has been funded by research grants and contracts from NSF, ARO and DHS and various state agencies.

## KEYNOTE TALK

Wednesday, November 21, 2018  
1:30 pm – 2:30 pm (Lotus Ballroom 1)

### Tensor Methods in Visual Computing

Renato Pajarola  
University of Zürich

#### Abstract

Tensor decomposition methods and multilinear algebra are emerging tools to cope with current trends in computer graphics, image processing and data visualization, in particular with respect to compact representation and processing of increasingly large-scale, high-dimensional and high-parametric data sets and models. Flexible and scalable mathematical models that can process, manipulate as well as compress, store and retrieve such data efficiently are therefore of increasing importance, especially for higher-dimensional data. Initially proposed as an extension of the concept of matrix rank for 3 and more dimensions, *tensor decomposition methods* have found applications in a remarkably wide range of disciplines. However, partly due to the notable initial learning costs, this mathematical framework has not reached yet all its potential awareness in the visual computing research community. In this talk I will introduce the most successful tensor decomposition models and review their application in graphics and visualization, as well as give insights into the benefits they offer and showcase specific applications such as visual data compression, signal processing, interactive manipulation, texture synthesis, and data-driven rendering



**Speaker Bio-Sketch:** Renato Pajarola is a full Professor in the Department of Informatics at the University of Zürich (UZH). He received a Dipl. Inf-Ing ETH as well as a Dr. sc. techn. degree in computer science from the Swiss Federal Institute of Technology (ETH) Zurich in 1994 and 1998 respectively. Subsequently he was a post-doctoral researcher and lecturer in the Graphics, Visualization & Usability Center at Georgia Tech. In 1999 he joined the University of California Irvine as an Assistant Professor where he established the Computer Graphics Lab. Since 2005 he has been leading the Visualization and MultiMedia Lab at UZH. He is a Senior Member of ACM and IEEE as well as a Fellow of the Eurographics Association. Dr. Pajarola's research interests include real-time 3D graphics, geometric modeling, point based graphics, interactive large-scale data visualization, remote and parallel rendering, compression and interactive 3D multimedia. He has published a wide range of internationally peer-reviewed research articles in top journals and conferences. Prof. Pajarola regularly serves on program committees, such as for example the IEEE Visualization Conference, Eurographics, EuroVis Conference, IEEE Pacific Visualization or ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games. He organized and co-chaired the Eurographics Conference in 2015, chaired the 2010 EG Symposium on Parallel Graphics and Visualization and was papers co-chair in 2011, and also of the 2007 and 2008 IEEE/EG Symposium on Point-Based Computer Graphics. His co-authored papers received a Eurographics Best Paper Award in 2005, an IADIS Best Paper Award in 2007, a SPIE Best Paper Award in 2013, a Best Student Paper at the Pacific Graphics Conference and an Honorable Mention Award at the ACM SIGGRAPH Symposium on Visualization in 2016.

# Steering Committee

Bebis George, University of Nevada, Reno, USA  
Boyle Richard, NASA Ames Research Center, USA  
Parvin Bahram, LBNL & University of Nevada, Reno, USA  
Koracin Darko, Desert Research Institute, USA

## Area Chairs

- *Computer Vision*

Ramalingam Srikumar, University of Utah, USA  
Turek Matt, DARPA, USA

- *Computer Graphics*

Xu Kai, National University of Defense Technology, China  
Lin Steve, Microsoft Asia, China

- *Virtual Reality*

Ventura Jonathan, University of Colorado at Colorado Springs, USA  
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