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Introduction

Foreword to Shape Modeling International 2014

The Shape Modeling International (SMI) conference provides an international forum for the dissemination of new mathematical theories and computational techniques for modeling, simulating and processing digital representations of shapes. Its target audience is the community of researchers, developers, students, and practitioners addressing these topics across a wide range of fields. Starting from 2001, the SMI conference became an annual event with the venue rotating in turn between Asia, Europe, and America. Previous conferences were organized in Japan (1997, 1999), Italy (2001), Canada (2002), South Korea (2003), Italy (2004), USA (2005), Japan (2006), France (2007), USA (2008), China (2009), France (2010), Israel (2011), USA (2012), and the UK (2013). The objective of the conference is to provide an international forum for the dissemination of new mathematical theories and computational techniques for modeling, simulation, and processing of digital representations of shapes. Its target audience is the community of researchers, developers, students, and practitioners addressing these topics across a wide range of fields.

Shape Modeling International 2013 was hosted by the Department of Mechanical and Automation Engineering, The Chinese University of Hong Kong (CUHK), Hong Kong, China. It was held in the Yasumoto International Academic Park on the campus of CUHK, from 28th of October to 30th of October, 2014. SMI'14 is organized jointly with 2014 International Symposium on Solid and Physical Modeling (SPM 2014), which was held from 26th of October to 28th of October, 2014. This is the third time that these two conferences are collocated, following 2005 at MIT and 2008 at Stony Brook.

All the accepted technical papers of SMI'14 are published in the journal Computers and Graphics (Elsevier); together the proceedings will constitute the first issue of the journal in 2015. SMI'13 received a total of 93 submissions from various countries including Austria, Canada, China, Denmark, France, Germany, India, Iran, Israel, Italy, Japan, Korea, Pakistan, Portugal, Saudi Arabia, UK and USA. Each paper underwent a two-stage review process. In the first round, each paper was read and reviewed by 4–5 reviewers. In the second round, papers that underwent major revisions were sent back to the reviewers to conduct a second review; papers that underwent minor revisions were resubmitted with a revision/rebuttal letter, which was reviewed by the chairs of international program committee (IPC). Of the 93 submissions, 33 articles were accepted, a yield of 35.5%. We would like to thank all the members of IPC for their hard work and thank all the authors for their contribution to the conference.

Three keynote speakers presented in SMI'14: Michael Kazhdan (Johns Hopkins University, USA), Jianmin Zheng (Nanyang Technological University, Singapore) and Jakob Andreas Bærentzen (Technical University of Denmark, Denmark).

SMI'14 was supported by the Department of Mechanical and Automation Engineering of CUHK, Croucher Foundation, and K.C. Wong Education Foundation. Besides, the program chairs wish to acknowledge the support and help of the conference chairs, Shuming Gao, John C. Hart, Joaquim Jorge, Konrad Polthier and Wenping Wang. Lastly, thanks are given to the local organizing team (especially Flora Au-Yeung) and the Elsevier Editorial office (especially Lisa Gordon and Fiona Isaac) – without their contribution, the event could not have been a success.

Program chairs:

Eitan Grinspun is Associate Professor of Computer Science at Columbia University in the City of New York. He was Professeur d'Université Invité at l'Université Pierre et Marie Curie in 2009, a Research Scientist at the Courant Institute of Mathematical Sciences from 2003 to 2004, and a doctoral student at the California Institute of Technology from 1997 to 2003, and an undergraduate in the Engineering Science program at the University of Toronto from 1993 to 1997. He received the National Science Foundation CAREER Award in 2007, and the Alfred P. Sloan Research Fellowship in 2010. He was selected as one of the “Ten Brilliant Scientists of 2011” by Popular Science Magazine, and one the “Most Creative People in Business and Innovation in 2013” by Fast Company Magazine. Prof. Grinspun investigates the connections between geometry, mechanics, and algorithms, with an eye to physical simulation techniques. The technologies developed by his lab are used today at major film studios, consumer software, and in various disciplines of academic research, spanning biology, engineering, graphics, mechanics, and medicine.

Alexander Pasko is a professor at The National Centre for Computer Animation, Bournemouth University, UK. He received his Ph.D. from Moscow Engineering Physics Institute (MEPhI) in Russia in 1988, where he was a senior scientist until 1992. He was an assistant professor at the department of computer software, University of Aizu, Japan (from 1993 to 2000); associate and full professor at the Faculty of Computer and Information Sciences of the Hosei University in Tokyo, Japan (2000–2007). Alexander Pasko's areas of interest are geometric and volume modeling, computer-aided design and 3D printing, computer animation and computer art. His main research interest is development of a high-level universal model for spatio-temporal objects and phenomena with their internal properties. The model called the Function Representation (FRep) is based on the most universal mathematical language of real functions of point coordinates in geometric spaces. Alexander was a co-founder of the Shape Modeling International conference series and he serves on its steering committee. He is an Editorial board member of the computer-aided Design journal and an Associate Editor of the International Journal of Computer Games technology, and also is a editorial board member of several international journals. He chaired and co-chaired multiple international conferences and gave a number of invited tutorials and talks worldwide. More details can be found at www.pasko.org/ap

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Dr. Charlie C.L. Wang is currently an Associate Professor at the Department of Mechanical and Automation Engineering, The Chinese University of Hong Kong. He gained his B. Eng. in Mechatronics Engineering from Huazhong University of Science and Technology, M. Phil. and Ph.D. in Mechanical Engineering from The Hong Kong University of Science and Technology. He is a Fellow of the American Society of Mechanical Engineers (ASME). Dr. Wang serves on the editorial board of a few journals including Computer-Aided Design, ASME Journal of Computing and Information Science in Engineering, and International Journal of Precision Engineering and Manufacturing. He has received a few awards including the ASME CIE Young Engineer Award (2009), the CUHK Young Researcher Award (2009), the CUHK Vice-Chancellor's Exemplary Teaching Award (2008), the Best Paper Awards of ASME CIE Conferences (in 2008 and 2001), and the Prakash Krishnaswami CAPPD Best Paper Award of ASME CIE Conference in 2011. His research interests are geometric modeling, design and manufacturing, and computational physics.

International Program Committee:

Keynote Talk (October 28, 2014)

The Poisson System: From Images to Geometry

Michael Kazhdan John Hopkins University, USA

Abstract

In this talk we will consider a number of standard applications of the Poisson equation in the context of image processing. We will demonstrate that, from a theoretical perspective, these approaches are easily generalized to manifolds, enabling simple techniques for geometric processing and modeling. We will then discuss how the theory can be realized in practice, focusing on the challenges of discretizing the linear operator and implementing a hierarchical solver that enables interactive processing of huge meshes.

Biography

Michael Kazhdan is an associate professor in the Computer Science Department at Johns Hopkins University. His recent research has focused on the challenge of surface reconstruction and considers the manner in which Stokes's Theorem and Laplace's Equation can be used for distributed and out-of-core reconstruction of high resolution models from data consisting of hundreds of millions of points. He has also been working on problems in the domain of image-processing, developing efficient streaming algorithms for solving the large sparse linear systems associated with modeling terapixel images in the gradient-domain, and on problems in geometry processing, developing hierarchical techniques for efficiently solving the linear systems arising in surface deformation, parameterization, and evolution.

Keynote Talk (October 29, 2014)

Variational Geometric Processing

Jianmin Zheng Nanyang Technological University, Singapore

Abstract

With the increasing availability and use of digital 3D models, the demand is growing for techniques that can effectively create, analyze and process the geometry of models. Among various mathematical methods, variational approaches appear very suitable for some geometric processing tasks. In particular, the advance of sparse optimization techniques enables the geometric feature to be well preserved in geometric processing. In this talk, I will review a few variational algorithms in the area of geometric modeling. Then I will present our recent work on mesh segmentation and mesh reconstruction to showcase how the variational techniques can be applied to solve geometric processing problems. The emphasis will be put on variational formulation, sparse regularization and numerical solvers, which play important roles in producing effective geometric processing tools. The experience with these key technical components might be useful for future development of new variational geometric processing algorithms.

Biography

Jianmin Zheng is an associate professor in the School of Computer Engineering at Nanyang Technological University (NTU), Singapore. He received his B.S. and Ph.D. from Zhejiang University, China in 1986 and 1992, respectively. Prior to joining NTU in 2003, he was a post-doc and a research staff at Brigham Young University, and a professor in mathematics at Zhejiang University. His research covers computer aided geometric design, computer graphics, computer aided design and manufacturing, visualization, simulation, and interactive digital media. He has published over 100 papers in international journals and conferences such as ACM SIGGRAPH, ACM Transactions on Graphics and computer aided geometric design. He was the conference co-chair of Geometric Modeling and Processing 2014 and has served on the program committee of several international conferences. Currently, Dr. Zheng is an associate editor of The Visual Computer.

Keynote Talk (October 30, 2014)

Polygonal Mesh Co-Representations

Jakob Andreas Bærentzen Technical University of Denmark, Denmark

Abstract

Polygonal meshes underlie numerous methods for geometry processing and shape design as well as editing. However, for many operations, auxiliary data structures are needed. For instance, when tracking deformable interfaces represented as meshes, we need techniques for detecting and resolving collisions. Animation with linear blend skinning requires an armature and a set of skinning weights. These auxiliary data structures generally have no intrinsic relationship with the mesh and need to be maintained or rebuilt as the mesh changes. In this talk, we will discuss polygonal mesh co-representations which – for specific tasks – render auxiliary data structures superfluous. In particular, we trace the origins and discuss the merits of two concrete shape representations:

- The Deformable Simplicial Complex (DSC) method is a technique for tracking deformable interfaces. The interface is represented as a triangle mesh which is given as a set of faces of a tetrahedral mesh. As the interface evolves, the embedding tetrahedral grid is updated correspondingly. Topology changes are detected and resolved using the tetrahedral grid, but automatically reflected in the triangle mesh.
- Polar Annular Meshes (PAM) is a skeleton mesh co-representation. Seen as a mesh, a PAM consists exclusively of rings of quadrilaterals and triangle fans. These regions can be contracted to line segments, producing a skeleton which can be used for animation and editing operations that have no need for local parameterization or elaborate mesh surgery.

While DSC and PAM are very different approaches with little overlap in terms of applications, both subsume a mesh as an integral part of the representation. Since the volumetric information in the case of the DSC and the skeleton in the case of a PAM are conjoined with the mesh representation, we gain similar benefits. When a topological change occurs to a DSC represented shape, the co-represented mesh will automatically reflect this changed topology. Changes to the geometry of a PAM will automatically be reflected in the shape of the co-represented skeleton.

Biography

Andreas Bærentzen is an associate professor at the Department of Applied Mathematics and Computer Science at the Technical University of Denmark which is in Lyngby just north of Copenhagen, Denmark. Andreas also received his M.Sc. and Ph.D. from the Technical University of Denmark. Andreas' research area is computer graphics with emphasis on the digital representation of shape. In particular, he investigates shape representation and manipulation methods for applications such as interactive sculpting, simulation and modeling of dynamic phenomena, procedural synthesis of 3D models, and the creation of digital prototypes. He is also interested in many aspects of real-time graphics.