## **Final Program and Abstracts**



This conference is sponsored by the SIAM Activity Group on Geometric Design and in cooperation with ACM SIGGRAPH, incorporating the 2013 SIAM Conference on Geometric Design and the 2013 Symposium on Solid and Physical Modeling.

The SIAM Activity Group on Geometric Design is concerned with the mathematical and computational issues that arise in generating and processing geometric information for various engineering applications, such as mechanical design, process planning, and manufacturing. The scope of the group's activities encompasses a wide spectrum of scientific, technological, and other skills, ranging from rigorous mathematics to the subjective aesthetics of shape. The SIAG organizes a biennial conference and also maintains a website, a member directory, and an electronic mailing list. For details please see the SIAG GD website (http://www.siam.org/activity/gd/).



www.siam.org/meetings/gdspm13

2013 SIAM Conference on Geometric and Physical Modeling

### **Table of Contents**

Program-at-a-Glance Fold out section
General Information2
Get-togethers7
Invited Plenary Presentations8
Prizes and Awards9
Program Schedule
Welcome Reception
and Poster Session14
Abstracts
Speaker and Organizer Index43
Conference Budget47
Hotel Meeting Room Map Back Cover

#### **Organizing Committee**

General Co-Chairs Elaine Cohen University of Utah, USA

**Stefanie Hahmann** University Grenoble INP, France

Konrad Polthier Freie Universität Berlin, Germany

Wenping Wang Hong Kong University, Hong Kong

### **Program Co-chairs**

Kai Hormann Università della Svizzera italiana, Lugano, Switzerland

Sara McMains University of California, Berkeley, USA

**Georg Umlauf** University of Applied Science Constance, Germany

#### Program Committee

Chandrajił Bajaj University of Texas at Austin, USA

Loïc Barthe Université Paul Sabatier, Toulouse, France

**Carolina Beccari** Università di Bologna, Italy

**Dominique Bechmann** Université de Strasbourg, France

Alexander Belyaev Heriot-Watt University, United Kingdom

Mirela Ben-Chen Technion, Haifa, Israel George-Pierre Bonneau GRAVIR-IMAG, France

**David Bonner** Dassault Systemes, France

Wim Bronsvoort U Delft, Netherlands

Guido Brunnett TU Chemnitz, Germany

**Costanza Conti** Università degli Studi di Firenze, Italy

Jiansong Deng University of Science and Technology of China, Hefei, China

Chongyang Deng Hangzhou Dianzi University, Hangzhou, China

Tamal Dey Ohio State University, USA

Tor Dokken SINTEF, Norway

Gershon Elber Technion, Israel

**Shuming Gao** Zhejiang University, China

Ron Goldman Rice University, USA

Daniel Gonsor Boeing, USA

Thomas Grandine Boeing, USA

Jens Gravesen TU Denmark, Denmark

**Cindy Grimm** Oregon State University, USA

Balan Gurumoorthy Indian Institute of Science, India

Hans Hagen University of Kaiserslautern, Germany

**Stefanie Hahmann** University of Grenoble, France

**Dan Halperin** Tel Aviv University, Israel

Iddo Hanniel Technion, Israel

Dianne Hansford Arizona State University, USA

Ying He Nanyang Technological University, Singapore

Martin Hering-Bertram University of Applied Science Bremen, Germany Christoph Hoffmann Purdue University, USA

Hugues Hoppe Microsoft Research, USA

**Shi-Min Hu** Tsinghua University, China

**Qixing Huang** Stanford University, USA

Horea llies University of Connecticut, USA

Ravi Janardan University of Minnesota, USA

**Robert Joan-Arinyo** Universitat Politecnica de Catalunya, Spain

**Leo Joskowicz** The Hebrew University of Jerusalem, Israel

**Tao Ju** Washington University at St. Louis, USA

Bert Jüttler Johannes Kepler Universität Linz, Austria

John Keyser Texas A&M University, USA

**Myung-Soo Kim** Seoul National University, Korea

**Deok-Soo Kim** Hanyang University, Korea

Young Kim Ewha Womans University, South Korea

Leif Kobbelt RWTH Aachen, Germany

Adarsh Krishnamurthy University of California, San Diego, USA

**Yu-Kun Lai** Cardiff University, United Kingdom

Kunwoo Lee Seoul National University, Korea

Jyh-Ming Lien George Mason University, USA

André Lieutier Dassault Systèmes, France

Yaron Lipman Weizmann Institute of Science, Rehovot, Israel

Ligang Liu University of Science and Technology of China, China

**Yong-Jin Liu** Tsinghua University, China

Weiyin Ma City University of Hong Kong, Hong Kong Stephen Mann University of Waterloo, Canada

Carla Manni Università di Roma "Tor Vergata", Italy

Dinesh Manocha University of North Carolina, USA

Ralph Martin Cardiff University, United Kingdom

Niloy Mitra University College London, United Kingdom

**Géraldine Morin** University of Toulouse, France

Yutaka Ohtake The University of Tokyo, Japan

Martin Peternell Technical University of Vienna, Austria

Jorg Peters University of Florida, USA

Tom Peters University of Connecticut, USA

Konrad Polthier Freie Universität Berlin, Germany

Helmut Pottmann TU Wien, Austria

Hartmut Prautzsch Karlsruhe University, Germany

Xiaoping Qian Illinois Institute of Technology, USA

**Ewald Quak** Tallinn University of Technology, Estonia

Karthik Ramani Purdue University, USA

William Regli Drexel University, USA

Ulrich Reif Darmstadt Technical University, Germany

Richard Riesenfeld University of Utah, USA

Lucia Romani University of Milano-Bicocca, Italy

Jarek Rossignac Georgia Institute of Technology, USA

Maria Lucia Sampoli Università degli Studi di Siena, Italy

Nickolas Sapidis University of Western Macedonia, Greece

Scott Schaefer Texas A&M University, USA

Vadim Shapiro University of Wisconsin, USA Kenji Shimada Carnegie Melon University, USA

Claudio Silva New York University, USA

Olga Sorkine ETH Zurich, Switzerland

**Tim Strotman** Parasolid Components, Siemens PLM Software, USA

Hiromasa Suzuki University of Tokyo, Japan

Kai Tang Hong Kong University of Science and Technology, China

George Turkiyyah American University of Beirut, Lebanon

Jan Vandenbrande Boeing, USA

Tamás Várady Budapest University of Technology and Economics, Hungary

Luiz Velho IMPA, Brazil

Johannes Wallner TU Graz, Austria

Charlie Wang Chinese University of Hong Kong, Hong Kong

Wenping Wang The University of Hong Kong, Hong Kong

Joe Warren Rice University, USA

**Ofir Weber** University of Haifa, Israel

**Chee Yap** New York University, USA

Thomas Yu Drexel University, USA

**Emil Zagar** University of Ljubljana, Slovenia

Yongjie (Jessica) Zhang Carnegie Mellon University, USA

### **SIAM Registration Desk**

The SIAM registration desk is located in the Jax Room and Foyer. It is open during the following hours:

Sunday, November 10 5:00 PM - 7:00 PM

Monday, November 11 7:00 AM - 4:15 PM

Tuesday, November 12 7:30 AM - 4:00 PM

Wednesday, November 13 7:30 AM - 4:15 PM

Thursday, November 14 7:30 AM - 2:30 PM

### **Hotel Address**

The Curtis, A DoubleTree by Hilton Hotel 1405 Curtis Street Denver, CO 80202 USA Phone Number: +1-303-571-0300 Toll Free Reservations (USA and Canada): +1-800-525-6651

Fax: +1-303-825-4301

### Hotel Telephone Number

To reach an attendee or to leave a message, call +1-303-571-0300. The hotel operator can either connect you with the SIAM registration desk or to the attendee's room. Messages taken at the SIAM registration desk will be posted to the message board located in the registration area.

### Hotel Check-in and Check-out Times

Check-in time is 3:00 PM and check-out time is 12:00 PM.

### **Child Care**

For child care services in Denver, please contact Rachel Romkey at the Amelia Agency, a fully licensed child care provider, at 303-255-4928, or visit online at *www.theameliaagency.com*.

### Corporate Members and Affiliates

SIAM corporate members provide their employees with knowledge about, access to, and contacts in the applied mathematics and computational sciences community through their membership benefits. Corporate membership is more than just a bundle of tangible products and services; it is an expression of support for SIAM and its programs. SIAM is pleased to acknowledge its corporate members and sponsors. In recognition of their support, non-member attendees who are employed by the following organizations are entitled to the SIAM member registration rate.

### Corporate Institutional Members

The Aerospace Corporation

Air Force Office of Scientific Research

AT&T Laboratories - Research

Bechtel Marine Propulsion Laboratory

The Boeing Company

CEA/DAM

Department of National Defence (DND/ CSEC)

DSTO- Defence Science and Technology Organisation

Hewlett-Packard

**IBM** Corporation

IDA Center for Communications Research, La Jolla

IDA Center for Communications Research, Princeton

Institute for Computational and Experimental Research in Mathematics (ICERM)

Institute for Defense Analyses, Center for Computing Sciences

Lawrence Berkeley National Laboratory

Lockheed Martin

Los Alamos National Laboratory

Mathematical Sciences Research Institute

Max-Planck-Institute for Dynamics of Complex Technical Systems

Mentor Graphics

National Institute of Standards and Technology (NIST)

National Security Agency (DIRNSA)

Oak Ridge National Laboratory, managed by UT-Battelle for the Department of Energy

Sandia National Laboratories

Schlumberger-Doll Research

Tech X Corporation

U.S. Army Corps of Engineers, Engineer Research and Development Center

United States Department of Energy

List current September 2013.

## **Funding Agency**

SIAM and the Conference Organizing Committee wish to extend their thanks and appreciation to the U.S. National Science Foundation for its support of this conference.



# Leading the applied mathematics community... Join SIAM and save!

SIAM members save up to \$130 on full registration for the 2013 SIAM Conference on Geometric and Physical Modeling (GD/SPM13). Join your peers in supporting the premier professional society for applied mathematicians and computational scientists. SIAM members receive subscriptions to *SIAM Review* and *SIAM News* and enjoy substantial discounts on SIAM books, journal subscriptions, and conference registrations.

If you are not a SIAM member and paid the *Non-Member* or *Non-Member Mini Speaker/Organizer* rate to attend the conference, you can apply the difference between what you paid and what a member would have paid (\$130 for a *Non-Member* and \$65 for a *Non-Member Mini Speaker/Organizer*) towards a SIAM membership. Contact SIAM Customer Service for details or join at the conference registration desk.

If you are a SIAM member, it only costs \$10 to join the SIAM Activity Group on Geometric Design (SIAG/ GD). As a SIAG/GD member, you are eligible for an additional \$10 discount on this conference, so if you paid the SIAM member rate to attend the conference, you might be eligible for a free SIAG/GD membership. Check at the registration desk.

Free Student Memberships are available to students who attend an institution that is an Academic Member of SIAM, are members of Student Chapters of SIAM, or are nominated by a Regular Member of SIAM.

Join onsite at the registration desk, go to *www.siam.org/joinsiam* to join online or download an application form, or contact SIAM Customer Service: Telephone: +1-215-382-9800 (worldwide); or 800-447-7426 (U.S. and Canada only) Fax: +1-215-386-7999 E-mail: membership@siam.org

Postal mail: Society for Industrial and Applied Mathematics, 3600 Market Street, 6<sup>th</sup> floor, Philadelphia, PA 19104-2688 USA



## Simulation, Optimization, and Identification in Solid Mechanics

## August 4-August 15, 2014 *Linz, Austria*



The fifth Gene Golub SIAM Summer School, with a focus on solid mechanics, will take place in the Johann Radon Institute for Computational and Applied Mathematics (RICAM), located at the Johannes Kepler University Linz, Austria.

This summer school will foster advanced knowledge for the participating graduate students in several areas related to simulated materials in solid mechanics. Within this broad field the summer school will concentrate on four key issues, namely

- 1. Identification of material parameters from measurements
- 2. Material- and topology-optimization
- 3. Optimization subject to variational inequalities
- 4. Adaptive discretization

The first two topics will provide a platform for in-depth discussions on the relation of the areas of identification and optimization. The third topic will augment the first two, by providing insight into the behavior of those problems for which variational inequalities are required for the modeling of the materials. Finally, the summer school will look at adaptive discretization of optimization problems for the purpose of reducing the computational costs involved in the solution of the problems encountered in the first three key topics.

#### The primary lecturers for these courses will be:

- Roland Herzog, TU Chemnitz, Germany
- Esther Klann, JKU Linz, Austria
- Michael Stingl, FAU Erlangen-Nürnberg, Germany
- Winnifried Wollner, University of Hamburg, Germany

Applicants selected to participate pay no registration. Funding for local accommodations and meal expenses will be available for all participants. Limited travel funds are also available.

#### Application deadline: February 1, 2014

For more detail on the courses and on how to apply, go to: <u>http://www.math.uni-hamburg.de/g2s3</u>

## www.siam.org/students/g2s3/

Sponsored by SIAM through an endowment from the estate of Gene Golub. For more information about prior summer schools go to www.siam.org/students/g2s3/



Society for Industrial and Applied Mathematics

3600 Market Street, 6th Floor • Philadelphia, PA 19104-2688 USA • +1-215-382-9800 • siam@siam.org • www.siam.org

## Standard Audio/Visual Set-Up in Meeting Rooms

SIAM does not provide computers for any speaker. When giving an electronic presentation, speakers must provide their own computers. SIAM is not responsible for the safety and security of speakers' computers.

The Plenary Session Room will have two (2) screens, one (1) data projector and one (1) overhead projector. Cables or adaptors for Apple computers are not supplied, as they vary for each model. Please bring your own cable/adaptor if using an Apple computer.

All other concurrent/breakout rooms will have one (1) screen and one (1) data projector. Cables or adaptors for Apple computers are not supplied, as they vary for each model. Please bring your own cable/adaptor if using an Apple computer. Overhead projectors will be provided only if requested.

If you have questions regarding availability of equipment in the meeting room of your presentation, or to request an overhead projector for your session, please see a SIAM staff member at the registration desk.

If you have questions regarding availability of equipment in the meeting room of your presentation, or to request an overhead projector for your session, please see a SIAM staff member at the registration desk.

## **E-mail Access**

Email stations are available to attendees during registration hours.

The Curtis, A DoubleTree Hotel, offers complimentary wireless Internet access to hotel guests in the lodging, public and meeting space areas. The password will be provided at check-in. Attendees not staying at the conference hotel can acquire the password from the SIAM registration desk.

### **Registration Fee Includes**

- Admission to all technical sessions
- Business Meeting (open to SIAG/GD members)
- Coffee breaks daily
- Room set-ups and audio/visual equipment
- SMA Business Meeting
- Welcome Reception and Poster Session

## **Conference Dinner Banquet**

### (separate fee applies)

A conference banquet will be held in the conference hotel on Wednesday, November 13 at 7:30 PM. Tickets are available for \$45 per person and will include a three-course meal. A cash bar will be offered. If you wish to attend the banquet and have not purchased a ticket, please visit the SIAM registration desk no later than 12:00 PM on Monday, November 11.

## Proceedings

The proceedings will be published as a journal special issue in Computer-Aided Design. Papers will be available for download during the conference from Elsevier for those who do not subscribe to the journal.

## Job Postings

Please check with the SIAM registration desk regarding the availability of job postings or visit *http://jobs.siam.org*.

### Important Notice to Poster Presenters

The poster session is scheduled for 6:00 PM on Monday, November 11. Poster presenters are requested to set up their poster material on the provided 4' x 8' poster boards in the Marco Polo Room between the hours of 2:00 PM and 6:00 PM. All materials must be posted by 6:00 PM on Monday, the official start time of the session. Poster displays must be removed at the conclusion of the session (8:00 PM). Posters remaining after this time will be discarded. SIAM is not responsible for discarded posters.

## SIAM Books and Journals

Display copies of books and complimentary copies of journals are available on site. SIAM books are available at a discounted price during the conference. If a SIAM books representative is not available, completed order forms and payment (credit cards are preferred) may be taken to the SIAM registration desk. The books table will close at 10:30 AM on Thursday, November 14.

## Table Top Displays

Elsevier SIAM

## Name Badges

A space for emergency contact information is provided on the back of your name badge. Help us help you in the event of an emergency!

## Comments?

Comments about SIAM meetings are encouraged! Please send to:

Sven Leyffer, SIAM Vice President for Programs (*vpp@siam.org*)

## Get-togethers

 Welcome Reception and Poster Session Monday, November 11 6:00 PM – 8:00 PM



- SMA Meeting (open to all attendees) Wednesday, November 13
   6:00 PM - 6:30 PM
- SIAG/GD Business Meeting (open to SIAG/GD members) Wednesday, November 13
   6:30 PM – 7:15 PM Complimentary beer and wine will be served.



 Conference Dinner Banquet Wednesday, November 13 7:30 PM (separate fee applies) See page 6 for details.

### **Please Note**

SIAM is not responsible for the safety and security of attendees' computers. Do not leave your laptop computers unattended. Please remember to turn off your cell phones, pagers, etc. during sessions.

## **Recording of Presentations**

Audio and video recording of presentations at SIAM meetings is prohibited without the written permission of the presenter and SIAM.

### Social Media

SIAM is promoting the use of social media, such as Facebook and Twitter, in order to enhance scientific discussion at its meetings and enable attendees to connect with each other prior to, during and after conferences. If you are tweeting about a conference, please use the designated hashtag to enable other attendees to keep up with the Twitter conversation and to allow better archiving of our conference discussions. The hashtag for this meeting is #GDSPM13.

## **Invited Plenary Speakers**

\*\*All Invited Plenary Presentations will take place in the Peek-a-Boo Room. \*\*

## Monday, November 11

8:00 AM - 9:00 AM

IP1 Thinking Outside the CAD Box: Geometric Design in the Age of 3D Printing Hod Lipson, Cornell University, USA

### 2:15 PM - 3:15 PM

IP2 Invited speaker To Be Determined

## Tuesday, November 12 2:00 PM - 3:00 PM

IP3 FMaps Algebraic Tools for Reasoning about Shapes and their Collections Mirela Ben-Chen, Technion, Israel Institute of Technology, Israel

## Wednesday, November 13 8:00 AM - 9:00 AM

IP4 Hierarchical Data Structures for Freeform Geometric Models Myung-Soo Kim, Seoul National University, Korea

## 2:15 PM - 3:15 PM

IP5 Topological Methods for Data Understanding and Exploration Vijay Natarajan, Indian Institute of Science, Bangalore, India

> Thursday, November 14 8:00 AM - 9:00 AM

IP6 Geometry in CAD Systems: Past, Present, and Future George Allen, Siemens PLM Software, China

# **Prizes and Awards**

\*\* Prizes and Awards Presentations will take place in the Peek-a-Boo Room.\*\*

### Tuesday, November 12

### 5:20 PM - 5:30 PM

### **Best Paper Awards**

The Solid Modeling Association will present the best paper awards immediately prior to the Pierre Bézier Award Lecture.

## 5:30 PM - 6:15 PM Pierre Bézier Award Lecture

Recipient to be announced

# Notes

# GD/SPM13 Program



November 11-14, 2013 the Curtis-a DoubleTree by Hilton Hotel Denver, Colorado, USA

# Sunday, November 10

Registration 5:00 PM-7:00 PM Room:Jax and Foyer

# Monday, November 11

Registration 7:00 AM-4:15 PM Room:Jax and Foyer

## Welcoming Remarks

7:45 AM-8:00 AM Room:Peek-a-Boo

# IP1

### Thinking Outside the CAD Box: Geometric Design in the Age of 3D Printing 8:00 AM-9:00 AM

Room:Peek-a-Boo

Chair: Elaine Cohen, University of Utah, USA

For the last four decades, CAD tools have played an increasingly critical role in the product design process and in shaping our design thinking. But with the advent of 3D printing, traditional geometric modeling isn't keeping pace. While CAD systems have become faster, cheaper, and easier to use, they offer only limited access to the vast new space of geometric complexity now within our reach. This talk will outline new design and geometric representation paradigms that are emerging (and sometimes re-emerging): From generative geometry and evolutionary design, to multimaterial topological optimization and dynamical blueprints.

Hod Lipson Cornell University, USA Monday, November 11

# PS1

## Full Paper Presentations: Manufacturing and Interactive Applications

9:00 AM-10:40 AM

Room:Peek-a-Boo

Chair: Charlie Wang, The Chinese University of Hong Kong, Hong Kong

#### 9:00-9:20 Geometric Computation and Optimization on Tolerance Dimensioning

Songgang Xu and John Keyser, Texas A&M University, USA

# 9:25-9:45 Geometric Interoperability with Queries

Chris Hoffmann, Purdue University, USA; Vadim Shapiro, University of Wisconsin, Madison, USA; Vijay Srinivasan, National Institute of Standards and Technology, USA

#### 9:50-10:10 Automated Fixture Configuration for Rapid Manufacturing Planning

Saigopal Nelaturi, Arvind Rangarajan, Christian Fritz, and Tolga Kurtoglu, Palo Alto Research Center, USA

#### 10:15-10:35 Computation of Components' Interfaces in Highly Complex Assemblies

François Jourdes and Georges-Pierre Bonneau, INRIA, France; *Stefanie Hahmann*, Grenoble University, France; Jean-Claude Léon and François Faure, INRIA, France

## **Coffee Break**



Room: Patty-Cake and Curtis Street

10:40 AM-11:10 AM

Monday, November 11

# PS2

## Full Paper Presentations: Isogeometric Analysis and Surface Modelling

11:10 AM-12:50 PM

#### Room:Peek-a-Boo

Chair: Yongjie Zhang, Carnegie Mellon University, USA

11:10-11:30 Implicit Matrix Representations of Rational Bézier Curves and Surfaces

Laurent Busé, INRIA Sophia Antipolis, France

11:35-11:55 Isogeometric Analysis on Triangulations

Noah Jaxon and Xiaoping Qian, Illinois Institute of Technology, USA

#### 12:00-12:20 A Unified Method for Hybrid Subdivision Surface Design Using Geometric Partial Differential Equations

Qing Pan, Hunan University, China; Guoliang Xu, Academia Sinica, China; Yongjie Zhang, Carnegie Mellon University, USA

#### 12:25-12:45 An Optimization Approach for Constructing Tri-Variate B-Spline Solids

Xilu Wang and Xiaoping Qian, Illinois Institute of Technology, USA

## Lunch Break

12:50 PM-2:15 PM

Attendees on their own

Monday, November 11

IP2 Invited Speaker To Be Determined 2:15 PM-3:15 PM

Room:Peek-a-Boo

## Coffee Break

3:15 PM-3:45 PM

5 PM

Room:Patty-Cake and Curtis Street

## Monday, November 11

## MS1 Forward Looking Session 2013 - Part I of II

3:45 PM-5:45 PM

Room:Peek-a-Boo

#### For Part 2 see MS2

Forward Looking Sessions and Panel Discussions were run at the previous three conferences in San Antonio in 2007, San Francisco in 2009 and Orlando 2011. Again the goal is to suggest topics for future research, which are interesting and of practical industrial relevance, in the subject areas covered by the conference and the SIAM Activity Group for Geometric Design. The problems can span from being very specific, in need of a quick and concrete solution, to suggesting a whole new line of research. The subsequent panel discussion is again intended for lively discussions of future directions involving all conference participants.

Organizer: Ewald Quak Tallinn Technical University, Estonia

#### 3:45-4:10 Geometric Modeling with Convolutions

Thomas A. Grandine, The Boeing Company, USA

#### 4:15-4:40 Trends in Geometric Representations

George Allen, Siemens PLM Software, China

4:45-5:10 New Challenges in Isogeometric Analysis Tor Dokken, SINTEF, Norway

# 5:15-5:40 Challenges in Geospatial Applications

*Ewald Quak*, Tallinn Technical University, Estonia

2013 SIAM Conference on Geometric and Physical Modeling

Monday, November 11

## PS3 Short Paper Presentations: Session 1

3:45 PM-5:45 PM

#### Room:Keep Away

Chair: Xiaoping Qian, Illinois Institute of Technology, USA

#### 3:45-4:00 Robust Cascading of Operations on Polyhedra

Elisha Sacks, Purdue University, USA; Victor Milenkovic, University of Miami, USA

#### 4:05-4:20 Self-Overlapping Curves: Analysis and Applications

*Uddipan Mukherjee*, University of California, Irvine, USA

#### 4:25-4:40 Longest-Edge Algorithms for Size-Optimal Refinement of Triangulations

Carlos Bedregal and Maria-Cecilia Rivara, University of Chile, Chile

#### 4:45-5:00 Puzzhull: Cavity and Protrusion Hierarchy to Fit Conformal Polygons

Shanaz Mistry, *Niranjan U N*, and M. Gopi, University of California, Irvine, USA

#### 5:05-5:20 Precise Convex Hull Computation for Freeform Models Using a Hierarchical Gauss Map and Coons Bounding Volume Hierarchy

Yong-Joon Kim and Gershon Elber, Technion Israel Institute of Technology, Israel; Myung-Soo Kim, Seoul National University, Korea

#### 5:25-5:40 Linear Algebraic Representation for Topological Structures

Antonio DiCarlo and *Alberto Paoluzzi*, Università degli Studi Roma Tre, Italy; Vadim Shapiro, University of Wisconsin, Madison, USA

## Intermission

5:45 PM-6:00 PM

### Monday, November 11

# PP 1

## Welcome Reception and Poster Session

6:00 PM-8:00 PM

#### Room:Marco Polo

#### Geometrical-Computational Inverse Methods for Optimal Geometrical Deformation of Lumbar Artificial Disks Using the Numerical Reuleaux Method

Francisco Casesnoves, American Society Mechanical Engineering (Individual Researcher Member)

#### Finite Element Geometric Modeling of Traumatic Brain Injury for the Inverse Localization of Electrical Brain Activity Recorded Using Electroencephalography

Andrei Irimia, Sheng-Yang Goh, Carinna Torgerson, Micah Chambers, Nathan Stein, Jeffry Alger, and Paul Vespa, University of California, Los Angeles, USA; Ron Kikinis, Harvard Medical School, USA; John Van Horn, University of California, Los Angeles, USA

#### Redevelopment of Coastline Model for Procedural Modeling

Alex Pytel and *Stephen Mann*, University of Waterloo, Canada

#### Bladerunner: Surface Rationalisation for HotWire and HotBlade Technology

*Toke B. Nørbjerg*, Kasper Steenstrup, Jens Gravesen, David Brander, and Andreas Bærentzen, Technical University of Denmark, Denmark

# *C*<sup>2</sup> Quasi Arc-length Polynomial Approximation to Curves

Javier Sanchez-Reyes and Jesus Chacon, Universidad de Castilla-La Mancha, Spain

#### Protrusion Recognition from Solid Models Using Orthogonal Bounding Factor

Yoonhwan Woo, Hansung University, Korea

# Tuesday, November 12

### Registration

7:30 AM-4:00 PM Room:Jax and Foyer

# MS2

## Forward Looking Session 2013 - Part II of II

8:00 AM-10:00 AM

Room:Peek-a-Boo

### For Part 1 see MS1

Forward Looking Sessions and Panel Discussions were run at the previous three conferences in San Antonio in 2007, San Francisco in 2009 and Orlando 2011. Again the goal is to suggest topics for future research, which are interesting and of practical industrial relevance, in the subject areas covered by the conference and the SIAM Activity Group for Geometric Design. The problems can span from being very specific, in need of a quick and concrete solution, to suggesting a whole new line of research. The subsequent panel discussion is again intended for lively discussions of future directions involving all conference participants.

Organizer: Ewald Quak Tallinn Technical University, Estonia

# 8:00-8:25 Challenges in the Building Industry

Jens Gravesen, Technical University of Denmark, Denmark

# 8:30-8:55 Challenges in Simulation based Engineering

Stefan Boschert, Siemens AG Corporate Technology, Germany

#### 9:00-9:25 Efficient Geometry: Compositions and a Good Parametrization

Thomas A. Hogan, The Boeing Math Group, USA

### 9:30-9:55 Challenges for Geometric Design

Elaine Cohen, University of Utah, USA

Tuesday, November 12

## MS8 Shaping Surfaces 8:00 AM-10:00 AM

#### Room: Dodgeball

The minisymposium will discuss novel approaches to the modeling and texturing of surfaces. Given the vast need for new and exciting shapes in geometric design the four presentations of the minisymposium will discuss new approaches including the fast and stable computation of soap film surfaces, the generation of most symmetric shapes of high genus based on the theory of regular maps, the covering of complex surfaces with consistent and highly symmetric weavings, and on issues of efficient fabrication and modeling of complex shapes.

Organizer: Konrad Polthier Freie Universitaet Berlin, Germany

Organizer: Wenping Wang University of Hong Kong, Hong Kong

# 8:00-8:25 Symmetric Surfaces and Tilings

Konrad Polthier, Freie Universitaet Berlin, Germany

# 8:30-8:55 Modeling Cmc Surfaces with Cvt

Wenping Wang, University of Hong Kong, Hong Kong

#### 9:00-9:25 Geometric Issues with 3D Printing

Charlie Wang, The Chinese University of Hong Kong, Hong Kong

#### 9:30-9:55 Quad Pattern Coverable Meshes

Ergun Akleman, Texas A&M University, USA

Tuesday, November 12

## **PS4** Short Paper Presentations: Session 2

8:00 AM-10:00 AM

Room:Keep Away

Chair: Daniele Panozzo, ETH Zürich, Switzerland

8:00-8:15 Kinematic Skeleton Extraction from 3D Articulated Models Jaehwan Ma, Sunghee Choi, and *Jeong-Ho Son*, KAIST, Korea

#### 8:20-8:35 Modeling Piecewise Helix Curves from Sketches

*Nicolas Cherin*, Frederic Cordier, and Mahmoud Melkemi, University of Haute Alsace, France

#### 8:40-8:55 Modeling by Composition

*Gershon Elber*, Technion Israel Institute of Technology, Israel; Myung-Soo Kim, Seoul National University, Korea

#### 9:00-9:15 GaFinC: Gaze and Finger Control Interface for 3D Model Manipulation in CAD Application

Junbong Song, Sungmin Cho, Seung-Yeob Baek, Kunwoo Lee, and Hyunwoo Bang, Seoul National University, South Korea

#### 9:20-9:35 Modeling Flow Features with User-Guided Streamline Parameterization

Luoting Fu, *Levent Burak Kara*, and Kenji Shimada, Carnegie Mellon University, USA

#### 9:40-9:55 Electromagnetic Control of Charged Particulate Spray Systems - Models for Planning the Spray-Gun Operations

Debanjan Mukherjee and Tarek Zohdi, University of California, Berkeley, USA

## **Coffee Break**



Room: Patty-Cake and Curtis Street

10:00 AM-10:30 AM

## Tuesday, November 12

## MS3 Isogeometric Representation and Analysis - Part I of IV

10:30 AM-12:30 PM

Room:Peek-a-Boo

For Part 2 see MS5 Isogeometric Analysis (IGA),

introduced in 2005 by T.J.R. Hughes, replaces traditional Finite Elements by NonUniform Rational B-splines (NURBS), thus aligning FEA and CAD shape representation. While CAD-models focus on the overall shape accuracy and allow adjacent surfaces to not match exactly, FEA-models are required to have elements that match exactly with the element structure strongly influencing the quality of the analysis to be performed. The minisymposium will address state-of-the-art and identified research challenges of IGA as well as present selected research topics in more detail.

Organizer: Tor Dokken *SINTEF, Norway* 

Organizer: Michael Scott Brigham Young University, USA

10:30-10:55 LR B-splines Tor Dokken, SINTEF, Norway

11:00-11:25 LR B-Splines and Adaptive Refinement in Fluid Mechanics

Peter Nørtoft, Technical University of Denmark, Denmark

11:30-11:55 Hierarchical T-Splines Emily Evans, Michael Scott, and Derek C. Thomas, Brigham Young University, USA

#### 12:00-12:25 Isogeometric Spline Forests

Michael Scott, Derek C. Thomas, and Emily Evans, Brigham Young University, USA Tuesday, November 12

# MS4

## The Interplay Between Algebra AND Geometry: Applications In Solid Modeling

10:30 AM-12:30 PM

#### Room:Keep Away

Solid and Physical Modeling relies on how curves and surfaces are represented and manipulated when used in design, analysis and manufacturing. Curves and surfaces are the most typical objects of study in Geometry while polynomials, often used to represent them, are fundamental in Algebra. This minisymposium will introduce four concrete examples showing how fruitful can be the "simultaneous" use of algebraic and geometric techniques when dealing with applications in Solid and Physical Modeling. Topics considered will range from truncated hierarchical B-splines to solving transformation problems in Geodesy passing through considering collision detection problems and using cyclide splines in shape modeling.

#### Organizer: Laureano Gonzalez-Vega

Universidad de Cantabria, Spain

#### 10:30-10:55 Algebraic and Analysic Results for Truncated Hierarchical B-Splines

Bert Juettler, and Carlotta Giannelli, Johannes Kepler University Linz, Austria

#### 11:00-11:25 Free-Form Shape Modeling with Cyclides Splines

Pengbo Bo, Harbin Institute of Technology, China; *Wenping Wang*, University of Hong Kong, Hong Kong

#### 11:30-11:55 Collision-Detection and Distance-Related Computations for Freeform Geometric Models

*Myung-Soo Kim*, Seoul National University, Korea

#### 12:00-12:25 Curve Topology Certification Problems Arising in Geodesy: Transforming 3D Cartesian Coordinates To Geodetic Coordinates

Laureano Gonzalez-Vega, Universidad de Cantabria, Spain

### Tuesday, November 12

## **CP1** Curves and Surfaces

10:30 AM-12:30 PM

#### Room:Dodgeball

Chair: Iddo Hanniel, Technion - Israel Institute of Technology, Israel

#### 10:30-10:45 Geometric Characteristics of Quadric Bezier Triangular Patches

Alicia Cantón, *Leonardo Fernández-Jambrina*, Eugenia Rosado María, and María Jesús Vázquez Gallo, Universidad Politécnica de Madrid, Spain

#### 10:50-11:05 Aesthetic Spiral Design With Control Points

Rudrusamy Gobithaasan and Ramamoorthy Karpagavalli, University Malaysia Terengganu, Malaysia; Kenjiro Miura, Shizuoka University, Japan

#### 11:10-11:25 Fair Bi-4 Surfaces

*Kestutis Karciauskas*, Vilnius University, Lithuania; Jorg Peters, University of Florida, USA

#### 11:30-11:45 Volume-Oriented Tangential Redistribution of Points on Evolving Manifolds

Mariana Remesikova, Karol Mikula, and Peter Sarkoci, Slovak University of Technology, Slovakia; Daniel Sevcovic, Comenius University, Bratislava, Slovakia

#### 11:50-12:05 Complete Log-Aesthetic Surfaces by Logarithmic Helical Sweep

*Kenji Shikano* and Takafumi Saito, Tokyo University of Agriculture and Technology, Japan; Norimasa Yoshida, Nihon University, Japan

# 12:10-12:25 Selective Degree Elevation for Multi-Sided Bezier Patches

Jason Smith and Scott Schaefer, Texas A&M University, USA

## Lunch Break

12:30 PM-1:55 PM

Attendees on their own

### Remarks 1:55 PM-2:00 PM Room:Peek-a-Boo

## Tuesday, November 12

IP3

## FMaps - Algebraic Tools for Reasoning about Shapes and their Collections

2:00 PM-3:00 PM

Room:Peek-a-Boo

Chair: Kai Hormann, University of Lugano, Switzerland

Can you compare apples to oranges? When considering two geometric data sets (say an apple and an orange), the first question one could ask is "how similar are they", and the answer can be quantified by a single number. A more interesting question is "where do they differ?", because while both a horse and a human are different from a centaur, they are so in different ways. In this talk we will present FMaps - a new computational tool for reasoning about shapes, their differences and differences of differences. We will show how a simple change of perspective allows us to use standard linear algebra tools for complex tasks such as computing maps between shapes, analyzing and visualizing them, computing shape analogies and intrinsically aligning shape collections.

#### Mirela Ben-Chen

Technion - Israel Institute of Technology, Israel

## Coffee Break

3:00 PM-3:30 PM



Room: Patty-Cake and Curtis Street

Tuesday, November 12

# PS5

## **Combined Paper** (Full & Short) Presentations: Geometric Constraint Solving

3:30 PM-5:05 PM

#### Room:Peek-a-Boo

Chair: Jarek Rossignac, Georgia Institute of Technology, USA

#### 3:30-3:50 Continuous Penetration Depth

Xinyu Zhang, University of North Carolina at Chapel Hill, USA; Young J. Kim, Ewha Womans University, South Korea; Dinesh Manocha, University of North Carolina at Chapel Hill, USA

#### 3:55-4:15 Leading a Continuation Method by Geometry for Solving Geometric Constraints

Rémi Imbach, Pascal Schreck, and Pascal Mathis, University of Strasbourg, France

#### 4:20-4:40 Solving Multivariate **Polynomial Systems Using Hyperplane** Arithmetic and Linear Programming Iddo Hanniel, Technion - Israel Institute of

Technology, Israel

4:45-5:00 How the Beast Really Moves: Cayley Analysis of Mechanism Realization Spaces Using CayMos Meera Sitharam and Menghan Wang,

University of Florida, USA

### Siemens Sponsor Presentation

Room: Peek-A-Boo 5:05 PM-5:20 PM

### Tuesday, November 12

**SMA Best Paper Awards** Presentation 5:20 PM-5:30 PM

Room:Peek-a-Boo Chair: Sara McMains, University of California, Berkeley, USA

### Pierre Bezier Award Lecture

5:30 PM-6:15 PM Room:Peek-a-Boo Chair: Shi-Min Hu, Tsinghua University, China Recipient To Be Determined

Intermission 6:15 PM-6:30 PM

## Tuesday, November 12

## PD1 **Forward Lookina Panel Discussion**

6:30 PM-7:30 PM

Room:Peek-a-Boo Chair: Ewald Quak, Tallinn Technical University, Estonia

The Forward Looking Panel Discussion is intended to complement the Forward Looking Session similarly to the ones organized at the previous three conferences in San Antonio in 2007, San Francisco in 2009 and Orlando 2011. The members of the audience will have the opportunity to ask the panelists about important trends they perceive concerning the subject areas covered by the conference and the SIAM Activity Group for Geometric Design, hopefully leading to lively discussions of future directions involving all conference participants.

### Panelists:

George Allen Siemens PLM Software, China

Stefan Boschert Siemens AG Corporate Technology, Germany

**Elaine Cohen** University of Utah, USA

Tor Dokken SINTEF, Norway

**Thomas Grandine** The Boeing Company, USA

Jens Gravesen Technical University of Denmark, Denmark

Thomas Hogan The Boeing Math Group, USA



2013 SIAM Conference on Geometric and Physical Modeling

# Wednesday, November 13

### Registration

7:30 AM-4:15 PM Room:Jax and Foyer

### Remarks

7:55 AM-8:00 AM Room:Peek-a-Boo

## IP4

## Hierarchical Data Structures for Freeform Geometric Models,

8:00 AM-9:00 AM

Room:Peek-a-Boo

Chair: Wenping Wang, University of Hong Kong, Hong Kong

We present recent developments in the design of hierarchical data structures for freeform geometric models. The design of suitable data structures is essential in the acceleration of geometric algorithms for freeform curves and surfaces, in particular, when the freeform shapes are under continuous deformation. We demonstrate the performance improvement of various recent geometric algorithms over conventional results by orders of magnitude in computing time. We also show how the basic properties of spline functions can be used in the development of parametric data structures, their matching, and the Hausdorff distance bounding.

Myung-Soo Kim Seoul National University, Korea Wednesday, November 13

## **PS6** Full Paper Presentations: Shape Modelling

9:00 AM-10:40 AM

Room:Peek-a-Boo

Chair: Mirela Ben-Chen, Technion - Israel Institute of Technology, Israel

#### 9:00-9:20 Optimizing Polycube Domain Construction for Hexahedral Remeshing

Wuyi Yu, Kang Zhang, Shenghua Wan, and Xin Li, Louisiana State University, USA

#### 9:25-9:45 Improving Spatial Coverage While Preserving Blue Noise of Point Sets

Mohamed S. Ebeida, Sandia National Laboratories, USA; Muhammad Awad, Alexandria University, Egypt; Xiaoyin Ge, Ohio State University, USA; Ahmed Mahmoud, Alexandria University, Egypt; Scott A. Mitchell and Patrick M. Knupp, Sandia National Laboratories, USA; Li-Yi Wei, Hong Kong University, Hong Kong

#### 9:50-10:10 Extraction of Generative Processes from B-Rep Shapes and Application to Idealization Transformations

*Flavien Boussuge*, EADS Innovation Works, France; Jean-Claude Léon and Stefanie Hahmann, Grenoble University, France; Lionel Fine, EADS Innovation Works, France

#### 10:15-10:35 Geometry Seam Carving

*Ellen Dekkers* and Leif Kobbelt, RWTH Aachen University, Germany

### Coffee Break 10:40 AM-11:10 AM



Room: Patty-Cake and Curtis Street

Wednesday, November 13

## PS7

### Full Paper Presentations: Geometry and Topology Algorithms

11:10 AM-12:50 PM

Room:Peek-a-Boo

Chair: Gershon Elber, Technion Israel Institute of Technology, Israel

#### 11:10-11:30 A Parallel Algorithm for Improving the Maximal Property of Poisson Disk Sampling

*Xiang Ying*, Zhenhua Li, and Ying He, Nanyang Technological University, Singapore

#### 11:35-11:55 High-Quality Vertex Clustering for Surface Mesh Segmentation Using Student-t Mixture Model

Shoichi Tsuchie and Tikara Hosino, Nihon Unisys, Ltd., Japan; Masatake Higashi, Toyota Technological Institute, Japan

#### 12:00-12:20 Computing Voxelized 3D Minkowski Sums on the GPU

Wei Li and *Sara McMains*, University of California, Berkeley, USA

#### 12:25-12:45 A Simple and Local Method for Computing Teichmüller Map on 3D Surfaces

Minqi Zhang and Ying He, Nanyang Technological University, Singapore

### Lunch Break 12:50 PM-2:15 PM

Attendees on their own

Wednesday, November 13

## IP5

## Topological Methods for Data Understanding and Exploration

2:15 PM-3:15 PM

Room:Peek-a-Boo Chair: Stefanie Hahmann, Grenoble University, France

Scientific visualization aims to provide insights into data by generating a visual representation of the data and by providing methods for the user to interactively explore and interact with this representation. Topological methods, based on ideas from algebraic topology and Morse theory, have been successfully employed in the past decade to provide succinct and abstract representations of features in the data. One such topological structure is the Reeb graph, which is an abstract representation of the topology of all isosurfaces of a scalar field. In this talk, I will describe the role of the Reeb graph in the development of visualization methods for data from various science and engineering domains. I will focus on challenges in terms of efficient representation of the Reeb graph, fast computation, controlled simplification, and effective visualization.

Vijay Natarajan Indian Institute of Science, Bangalore, India

## Coffee Break

3:15 PM-3:45 PM



Room: Patty-Cake and Curtis Street

### Wednesday, November 13

## MS5 Isogeometric Representation and Analysis - Part II of IV

3:45 PM-5:45 PM

Room:Peek-a-Boo

### For Part 1 see MS3 For Part 3 see MS7

Isogeometric Analysis (IGA), introduced in 2005 by T.J.R. Hughes, replaces traditional Finite Elements by NonUniform Rational B-splines (NURBS), thus aligning FEA and CAD shape representation. While CAD-models focus on the overall shape accuracy and allow adjacent surfaces to not match exactly, FEA-models are required to have elements that match exactly with the element structure strongly influencing the quality of the analysis to be performed. The minisymposium will address state-ofthe-art and identified research challenges of IGA as well as present selected research topics in more detail.

Organizer: Tor Dokken SINTEF, Norway

Organizer: Mike Scott University of Texas, Austin, USA

3:45-4:10 Volumetric Isogeometric Descriptions Or Isogeometric Modeling of Complex Geometries

Yongjie Zhang, Carnegie Mellon University, USA

#### 4:15-4:40 From Design to Production: The TERRIFIC Demonstrator Part

Stefan Boschert, Siemens AG Corporate Technology, Germany

#### 4:45-5:10 Advances of the Meccano Method for Isogeometric Analysis of Irregular Planar Domains

José Iván López González, Marina Brovka, and José María Escobar Sánchez, University of Las Palmas de Gran Canaria, Spain; José Manuel Cascón Barbero, University of Salamanca, Spain; *Rafael Montenegro Armas*, University of Las Palmas de Gran Canaria, Spain

#### 5:15-5:40 Parametrization for Eigenvalue Problems in Isogeometric Analysis

Jens Gravesen, Technical University of Denmark, Denmark

## Wednesday, November 13

## MS6 Image and Shape Deformation

3:45 PM-5:45 PM

#### Room:Keep Away

Image deformation is a fundamental problem in Computer Graphics and Visualization. It is important to have interactive and intuitive tools for the user to efficiently manipulate images. The equivalent problem in 3D amounts to modifying the geometry of shapes, with applications in the movie and gaming industry. This minisymposium addresses recent trends in this area using advanced computational mathematical machinery.

Organizer: Mirela Ben-Chen Technion - Israel Institute of Technology, Israel

#### 3:45-4:10 Locally Injective Mappings

Christian Schüller, ETH Zürich, Switzerland; Ladislav Kavan, University of Pennsylvania, USA; *Daniele Panozzo* and Olga Sorkine-Hornung, ETH Zürich, Switzerland

#### 4:15-4:40 Bijective Composite Mean Value Mapping

*Teseo Schneider*, Universita' della Svizzera Italiana, Italy; Kai Hormann, University of Lugano, Switzerland; Michael Floater, University of Oslo, Norway

# 4:45-5:10 Planar Shape Interpolation with Bounded Distortion

Renjie Chen, Technion - Israel Institute of Technology, Israel; Ofir Weber and Danny Keren, University of Haifa, Israel; Mirela Ben-Chen, Technion - Israel Institute of Technology, Israel

#### 5:15-5:40 Hierarchical Deformation of Locally Rigid Meshes

Josiah M. Manson and *Scott Schaefer*, Texas A&M University, USA

Wednesday, November 13

## CP2 Applications and Simulations

3:45 PM-5:45 PM

#### Room:Dodgeball

Chair: George Allen, Siemens PLM Software, China

#### 3:45-4:00 Modeling of Countercurrent Two-Phase Interacting Flows: A Geometric Approach

Dmitry A. Altshuller, Dassault Systèmes, USA

4:05-4:20 On-Line Reconstruction of 3d Geometry

Klaus Denker, HTWG Konstanz, Germany

#### 4:25-4:40 Physical Models and Simulation in Procedural Modelina

Alex Pytel and Stephen Mann, University of Waterloo, Canada

### 4:45-5:00 Uniformly Triangulated Minimal Surfaces in Architecture

Karol Mikula, Martin Huska, Matej Medla, Peter Novysedlak, and Mariana Remesikova, Slovak University of Technology, Slovakia

#### 5:05-5:20 Earthquake Modeling with Lévy Processes

Indranil Sengupta, North Dakota State University, USA

#### 5:25-5:40 Adaptive Vehicle Make Design Performance Verification through Physics-based Simulation

James D. Walker, Sidney Chocron, Michael Moore, Greg Willden, and Charles Anderson, Southwest Research Institute, USA; John Riegel, R3 Technologies, Inc., USA; David Riha and John McFarland, Southwest Research Institute, USA; Ryan Alberson and David Stevens, Protection Engineering Consultants, USA

Intermission 5:45 PM-6:00 PM

## **SMA Meeting**

6:00 PM-6:30 PM Room:Peek-a-Boo



## SIAG/GD Business Meeting

6:30 PM-7:15 PM

Room:Peek-a-Boo

## Wednesday, November 13

## **Conference Dinner Banquet**

(optional fee event; ticket required) 7:30 PM-9:30 PM Room:Marco Polo See page 6 for additional details.

# Thursday, November 14

### Registration

7:30 AM-2:30 PM Room:Jax and Foyer

## **Closing Remarks**

7:55 AM-8:00 AM Room:Peek-a-Boo

# IP6

## Geometry in CAD Systems: Past, Present, and Future 8:00 AM-9:00 AM

Room:Peek-a-Boo Chair: Georg Umlauf, HTWG Konstanz, Germany

The internal workings of commercial CAD/CAM/CAE systems are typically something of a mystery to people outside the industry. The talk describes the evolution of geometric representations in commercial/industrial systems, in the hope that a better understanding of how we do things (and especially why we do them) will be of value to the research community. We describe the chaos of the early days, the relative calm and uniformity of today, and some likely directions for the future.

George Allen Siemens PLM Software, China

Intermission 9:00 AM-9:05 AM

Complimentary beer and wine will be served.

Thursday, November 14

## CP3 Isogeometric Analysis

9:05 AM-10:05 AM

Room:Peek-a-Boo

Chair: Tor Dokken, SINTEF, Norway

#### 9:05-9:20 Adaptive Meshes for Realistic Tokamaks Geometries Using IsoGeometric Analysis

Ahmed Ratnani and Virginie Grandgirard, CEA/DSM/IRFM Cadarache, France; Eric Sonnendrucker, Max-Planck-Institut für Plasmaphysik, Germany

#### 9:25-9:40 Shape Design and Isogeometric Analysis over An Arbitrary Parametrization Using Mapped Basis Functions

Xiaoyun Yuan and Weiyin Ma, City University of Hong Kong, Hong Kong

#### 9:45-10:00 Hierarchies Generated by Nested Generating Systems

Urska Zore and Bert Juettler, Johannes Kepler University of Linz, Austria Thursday, November 14

## CP4 Graphics and Visualization

9:05 AM-10:05 AM

Room:Keep Away

Chair: Vijay Natarajan, Indian Institute of Science, Bangalore, India

#### 9:05-9:20 Parameterization-Aware Mip-Mapping

Josiah M. Manson and Scott Schaefer, Texas A&M University, USA

#### 9:25-9:40 Topologically Informed, Geometrically Robust Molecular Visualization

*Thomas J. Peters* and Hugh Cassidy, University of Connecticut, USA; Kirk E. Jordan, IBM T.J. Watson Research Center, USA

#### 9:45-10:00 Using Adaptive Composite B-Spline Grid Generation to Enhance 3D Web Visualizations

Bonita V. Saunders, National Institute of Standards and Technology, USA

## **Coffee Break**

10:05 AM-10:30 AM

Room: Patty-Cake and Curtis Street

## Thursday, November 14

# MS7

## Isogeometric Representation and Analysis - Part III of IV

10:30 AM-12:00 PM

Room:Peek-a-Boo

#### For Part 2 see MS5 For Part 4 see MS9

Isogeometric Analysis (IGA), introduced in 2005 by T.J.R. Hughes, replaces traditional Finite Elements by NonUniform Rational B-splines (NURBS), thus aligning FEA and CAD shape representation. While CAD-models focus on the overall shape accuracy and allow adjacent surfaces to not match exactly, FEA-models are required to have elements that match exactly with the element structure strongly influencing the quality of the analysis to be performed. The minisymposium will address state-ofthe-art and identified research challenges of IGA as well as present selected research topics in more detail.

Organizer: Tor Dokken SINTEF, Norway

**I**B

Organizer: Mike Scott University of Texas, Austin, USA

# 10:30-10:55 Spline Forests for Discrete Differential Forms

Derek C. Thomas and Michael Scott, Brigham Young University, USA; Rafael Vazquez, Consiglio Nazionale delle Ricerche, Italy; John A. Evans, University of Colorado Boulder, USA

#### 11:00-11:25 Conservation of Geometry and Physics in Numerical Modeling of Incompressible Flow

John Evans, University of Colorado, Boulder, USA; Thomas Hughes, University of Texas, Austin, USA

#### 11:30-11:55 Spline Spaces Over Rectangle Meshes with Complex Topologies

*Andre Galligo*, Université de Nice, Sophia Antipolis, France; Bernard Mourrain and Meng Wu, INRIA Sophia Antipolis, France

Thursday, November 14

### CP5 Numerical Methods

10:30 AM-12:10 PM

Room:Keep Away

Chair: Myung-Soo Kim, Seoul National University, Korea

# 10:30-10:45 Nonlinear Diffusion Filtering of Data on the Earth's Surface

*Robert Cunderlik* and Karol Mikula, Slovak University of Technology, Slovakia

10:50-11:05 Mesh Denoising Via L0 Minimization

*Lei He* and Scott Schaefer, Texas A&M University, USA

#### 11:10-11:25 Laplace Inversion of Lr-Nmr Relaxometry Data Using Sparse Representation Methods

*Ofer Levi*, Paula Berman, and Yisrael Parmet, Ben Gurion University Negev, Israel; Michael A. Saunders, Stanford University, USA; Zeev Wiesman, Ben Gurion University Negev, Israel

#### 11:30-11:45 Balloon Darts: Fast Approximate Union Volume in High Dimensions with Line Samples

*Scott A. Mitchell* and Mohamed S. Ebeida, Sandia National Laboratories, USA

#### 11:50-12:05 Adaptively Weighted Numerical Integration over Arbitrary Domains

Vaidyanathan Thiagarajan and Vadim Shapiro, University of Wisconsin, Madison, USA

## Lunch Break

12:30 PM-2:00 PM

Attendees on their own

### Thursday, November 14

## MS9 Isogeometric Representation and Analysis - Part IV of IV

2:00 PM-3:30 PM

Room:Peek-a-Boo

#### For Part 3 see MS7

Isogeometric Analysis (IGA), introduced in 2005 by T.J.R. Hughes, replaces traditional Finite Elements by NonUniform Rational B-splines (NURBS), thus aligning FEA and CAD shape representation. While CAD-models focus on the overall shape accuracy and allow adjacent surfaces to not match exactly, FEA-models are required to have elements that match exactly with the element structure strongly influencing the quality of the analysis to be performed. The minisymposium will address state-of-the-art and identified research challenges of IGA as well as present selected research topics in more detail.

Organizer: Tor Dokken *SINTEF, Norway* 

Organizer: Mike Scott University of Texas, Austin, USA

2:00-2:25 Exploiting Components Interfaces and Functional Information to Generate FE Models of Assemblies Jean-Claude Leon, INRIA, France

2:30-2:55 From CAD to 3-Variate Spline Representation: The Terrific-Part Vibeke Skytt, SINTEF, Norway

3:00-3:25 Verification of Mechanical Engineering Finite Element Analysis

*Eric Florentin* and Sylvain Pavot, LMT-Cachan, France; Laurent Champaney, Arts et Metiers PARISTECH, France

# GD/SPM13 Abstracts



November 11-14, 2013 the Curtis-a DoubleTree by Hilton Hotel Denver, Colorado, USA

Abstracts are printed as submitted by the author.

Please Note: PS Paper Presentation Session abstracts are included under "CPO" abstracts.

#### IP1

#### Thinking Outside the CAD Box: Geometric Design in the Age of 3D Printing

For the last four decades, CAD tools have played an increasingly critical role in the product design process and in shaping our design thinking. But with the advent of 3D printing, traditional geometric modeling isnt keeping pace. While CAD systems have become faster, cheaper, and easier to use, they offer only limited access to the vast new space of geometric complexity now within our reach. This talk will outline new design and geometric representation paradigms that are emerging (and sometimes re-emerging): From generative geometry and evolutionary design, to multimaterial topological optimization and dynamical blueprints.

Hod Lipson Cornell University, USA hod.lipson@cornell.edu

#### IP2

## Conformalizing Mean Curvature Flow Computer Science or Mathematics?

In this talk we will revisit a well-studied problem from the mathematical community the formations of singularities in the mean curvature flow of 2D surfaces. Exploring the flow from the perspective of computer science, we relate the formation of singularities to a division-by-zero in the implementation. We show that a simple algorithmic modification that removes the division-by-zero also results in a geometrically simpler flow that empirically has been shown to evolve genus zero surfaces to conformal parameterizations over the round sphere.

#### Michael Kazhdan

Johns Hopkins University, USA misha@cs.jhu.edu

#### IP3

## FMaps - Algebraic Tools for Reasoning about Shapes and their Collections

Can you compare apples to oranges? When considering two geometric data sets (say an apple and an orange), the first question one could ask is "how similar are they", and the answer can be quantified by a single number. A more interesting question is "where do they differ?", because while both a horse and a human are different from a centaur, they are so in different ways. In this talk we will present FMaps - a new computational tool for reasoning about shapes, their differences and differences of differences. We will show how a simple change of perspective allows us to use standard linear algebra tools for complex tasks such as computing maps between shapes, analyzing and visualizing them, computing shape analogies and intrinsically aligning shape collections.

Mirela Ben-Chen

Technion - Israel Institute of Technology, Israel mirela@cs.technion.ac.il

#### $\mathbf{IP4}$

#### Hierarchical Data Structures for Freeform Geometric Models

We present recent developments in the design of hierarchical data structures for freeform geometric models. The design of suitable data structures is essential in the acceleration of geometric algorithms for freeform curves and surfaces, in particular, when the freeform shapes are under continuous deformation. We demonstrate the performance improvement of various recent geometric algorithms over conventional results by orders of magnitude in computing time. We also show how the basic properties of spline functions can be used in the development of parametric data structures, their matching, and the Hausdorff distance bounding.

#### Myung-Soo Kim

School of Computer Science and Engineering Seoul National University, Korea mskim@snu.ac.kr

#### IP5

## Topological Methods for Data Understanding and Exploration

Scientific visualization aims to provide insights into data by generating a visual representation of the data and by providing methods for the user to interactively explore and interact with this representation. Topological methods, based on ideas from algebraic topology and Morse theory, have been successfully employed in the past decade to provide succinct and abstract representations of features in the data. One such topological structure is the Reeb graph, which is an abstract representation of the topology of all isosurfaces of a scalar field. In this talk, I will describe the role of the Reeb graph in the development of visualization methods for data from various science and engineering domains. I will focus on challenges in terms of efficient representation of the Reeb graph, fast computation, controlled simplification, and effective visualization.

#### Vijay Natarajan

Indian Institute of Science, Bangalore Vijayn@csa.iisc.ernet.in

#### IP6

## Geometry in CAD Systems: Past, Present, and Future

The internal workings of commercial CAD/CAM/CAE systems are typically something of a mystery to people outside the industry. The talk describes the evolution of geometric representations in commercial/industrial systems, in the hope that a better understanding of how we do things (and especially why we do them) will be of value to the research community. We describe the chaos of the early days, the relative calm and uniformity of today, and some likely directions for the future.

George Allen Siemens PLM Software george.allen@siemens.com

#### CP0

#### Longest-Edge Algorithms for Size-Optimal Refinement of Triangulations

Longest-edge refinement algorithms were designed to iteratively refine the mesh for finite-element applications by maintaining the mesh quality (assuring a bound on the smallest angle). In this paper we improve geometrical results on longest-edge refinement algorithms and provide precise bounds on the refinement propagation. We prove that the iterative application of the algorithm gradually reduces the average extent of the propagation per target triangle, tending to affect only two triangles.

Carlos Bedregal, Maria-Cecilia Rivara University of Chile cbedrega@dcc.uchile.cl, mcrivara@dcc.uchile.cl

#### CP0

#### Extraction of Generative Processes from B-Rep Shapes and Application to Idealization Transformations

The construction tree produced during the design process of B-Rep objects does not bring all the desired properties in many configurations: dimension modifications, idealization processes. This paper proposes a primitive-based approach to extract generative processes from a given B-rep. The resulting construction graph generates a set of additive generative processes which, in the context of finite element analyses, can efficiently improve the idealizations of extracted primitives and ensure robust connections between them.

Flavien Boussuge EADS IW, Dept. Structure Eng., Production & Aeromechanics flavien.boussuge@eads.net

Jean-Claude Léon, Stefanie Hahmann Grenoble University /INRIA, Grenoble jean-claude.leon@grenoble-inp.fr, Stefanie.Hahmann@imag.fr

Lionel Fine EADS IW, Dept. Structure Eng., Production & Aeromechanics Suresnes, France lionel.fine@eads.net

#### CP0

#### Implicit Matrix Representations of Rational Bzier Curves and Surfaces

We introduce and study a new implicit representation of rational Bzier curves and surfaces in the 3-dimensional space. This representation consists of a matrix whose entries depend on the space variables and whose rank drops exactly on this curve or surface. Then, we show that these implicit matrix-based representations adapt geometric problems, such as intersection problems, to the powerful tools of numerical linear algebra, as the singular value decomposition, with a good numerical stability.

Laurent Busé INRIA Sophia Antipolis, France Laurent.Buse@inria.fr

#### CP0

#### Modeling Piecewise Helix Curves from Sketches

We describe a method for reconstructing piecewise helix curve from 2D sketch. The system takes as input a polygonal curve and generates a piecewise helix curve such that its orthogonal projection matches the input curve. The first step is an algorithm to generate a set of helices such that their orthogonal projection approximates the input curve. This step is followed by a global optimization to minimize the tangent discontinuity of the junctions of the helices.

<u>Nicolas Cherin</u>, Frederic Cordier, Mahmoud Melkemi University of Haute Alsace Nicolas.Cherin@uha.fr, fredcord@gmail.com, mahmoud.melkemi@uha.fr

#### $\mathbf{CP0}$

#### **Geometry Seam Carving**

We present a novel approach to feature-aware mesh deformation that combines elastic Laplacian editing with discrete plastic deformations by transferring the concept of seam carving from image retargeting to mesh deformation. During editing, a pre-computed set of triangle strips, or geometry seams, can be deleted or inserted in low saliency mesh regions, thereby distributing the deformation distortion non-homogeneously over the model which preserves salient features much better.

Ellen Dekkers RWTH Aachen University dekkers@cs.rwth-aachen.de

Leif Kobbelt RWTH Aachen University, Aachen, Germany kobbelt@informatik.rwth-aachen.de

#### $\mathbf{CP0}$

#### Improving Spatial Coverage While Preserving Blue Noise of Point Sets

A well-spaced blue-noise distribution of points has a random Fourier spectrum and small Voronoi cell aspect ratios. Totally random distributions have no aspect ratio bounds, and perfect tilings have no randomness. Smoothing a random input to locally optimize aspect ratios improves well-spacedness while preserving randomness. We simultaneously get good, middling values for both; better than CVT, Farthest Neighbor, and DistMesh. We show meshing and filtering applications.

<u>Mohamed S. Ebeida</u> Sandia National Laboratories msebeid@sandia.gov

Muhammad Awad Alexandria University muhammad.a.awad91@student.alx.edu.eg

Xiaoyin Ge Ohio State University gex@cse.ohio-state.edu

Ahmed Mahmoud Alexandria University eng.a.hassen@gmail.com

Scott A. Mitchell, Patrick M. Knupp Sandia National Laboratories samitch@sandia.gov, pknupp@sandia.gov

Li-Yi Wei Hong Kong University jedi@liyiwei.org

#### CP0

#### Modeling by Composition

Functional composition can be computed efficiently, robustly, and precisely over polynomials and piecewise polynomials represented in the Bezier and B-spline forms. In this work, as a testimony to the value of functional composition, we recall applications to curve-curve and curvesurface composition, and more extensively explore the surface-surface composition (SSC) in geometric modeling. We demonstrate the great potential of functional composition using several examples of the SSC operator, in geometric modeling applications.

<u>Gershon Elber</u> Technion, Haifa Israel gershon@cs.technion.ac.il

Myung-Soo Kim Seoul National University mskim.at.snu.ac.kr@gmail.com

#### $\mathbf{CP0}$

#### Computation of Components' Interfaces in Highly Complex Assemblies

This paper proposes a method to rapidly and fully automatically generate a precise geometric description of interfaces in generic B-Rep CAD models. The approach combines an efficient GPU ray-casting technique commonly used in computer graphics with a graph-based curve extraction algorithm. Not only is it able to detect a large number of interfaces efficiently, but it also provides an accurate Nurbs geometry of the interfaces, that can be stored in a plain STEP file.

François Jourdes INRIA françois.jourdes@gmail.com

Georges-Pierre Bonneau Laboratoire Jean Kuntzmann / INRIA georges-pierre.bonneau@inria.fr

<u>Stefanie Hahmann</u> Grenoble University /INRIA, Grenoble Stefanie.Hahmann@imag.fr

Jean-Claude Léon, François Faure LJK jean-claude.leon@inria.fr, francois.faure@inria.fr

#### CP0

#### Solving Multivariate Polynomial Systems Using Hyperplane Arithmetic and Linear Programming

We present a new method for solving systems of polynomial constraints, which scales nicely for systems with a large number of variables and relatively low degree. Such systems appear in many application domains. The method is based on the concept of bounding hyperplane arithmetic, which can be viewed as a generalization of interval arithmetic. We have implemented our method and present experimental results. The method is compared to previous methods and its advantages are discussed.

#### Iddo Hanniel

Technion, Israel Institute of Technology tba@siam.org

#### CP0

#### Leading a Continuation Method by Geometry for Solving Geometric Constraints

Geometric constraint problems arise in domains such as CAD, Robotics, Molecular Chemistry, whenever one expects 2D or 3D configurations of some geometric primitives fulfilling some geometric constraints. Most wellconstrained 3D problems are resistant to geometric methods. They are often solved by purely numerical methods that are efficient but provide only one solution. This paper focuses on using geometric knowledges to specialize a socalled coefficient parameter continuation to 3D geometric constraint systems.

<u>Rémi Imbach</u>, Pascal Schreck, Pascal Mathis Université de Strasbourg rimbach@unistra.fr, schreck@unistra.fr, mathis@unistra.fr

#### $\mathbf{CP0}$

#### **Isogeometric Analysis on Triangulations**

We present a method for isogeometric analysis on triangulation of a domain bounded by NURBS curves. Both the geometry and the physical field are represented by bivariate splines in Bernstein Bezier form over the triangulation. We describe a set of procedures to construct a parametric domain and construct Cr-smooth basis functions. This method is applicable to complex topologies and allows highly localized refinement. Isogeometric analysis of problems from linear elasticity and advection-diffusion analysis is demonstrated.

<u>Noah Jaxon</u>, Xiaoping Qian Illinois Institute of Technology njaxon@iit.edu, qian@iit.edu

#### $\mathbf{CP0}$

#### Modeling Flow Features with User-Guided Streamline Parameterization

We present a novel approach for designing streamlinebased, free-form surface features in the context of product design. The user first designs a network of streamlines on the base shape, by performing a stroke-constrained mesh parameterization. Then, the user utilizes these streamlines as a curvilinear scaffold for creating 3D features that are bounded and parameterized by them. The user applies fine-grained control of the resulting 3D features by manipulating the streamlines.

Luoting Fu, <u>Levent Burak Kara</u>, Kenji Shimada Carnegie Mellon University luoting.fu@cmu.edu, lkara@cmu.edu, shimada@cmu.edu

#### $\mathbf{CP0}$

#### Precise Convex Hull Computation for Freeform Models Using a Hierarchical Gauss Map and Coons Bounding Volume Hierarchy

We present an interactive-speed algorithm for computing the precise convex hull of freeform geometric models. The algorithm is based on two pre-built data structures: a Hierarchical Gauss map and a Coons bounding volume hierarchy. We recursively build approximate convex hulls using the data structures and eliminate the majority of redundant surface patches. In the final stage, we compute the precise trimmed surface patches on the convex hull boundary using numerical methods.

Yong-Joon Kim Technion kyj24182@gmail.com

Gershon Elber Technion, Haifa Israel gershon@cs.technion.ac.il

Myung-Soo Kim School of Computer Science and Engineering Seoul National University, Korea mskim@snu.ac.kr

#### $\mathbf{CP0}$

## Computing Voxelized 3D Minkowski Sums on the GPU

We present an algorithm for directly computing a voxelization of the Minkowski sum of two arbitrary closed watertight input polyhedra for applications such as path planning that do not require a boundary representation as output. We introduce a new decomposition formula for computing the Minkowski sum and prove its correctness. We describe an efficient Graphics Processing Unit (GPU) implementation of the algorithm using stencil shadow volumes to create a solid voxelization of the Minkowski sum.

Wei Li UC Berkeley liw@berkeley.edu

Sara McMains U.C. Berkeley Mechanical Engineering mcmains@me.berkeley.edu

#### $\mathbf{CP0}$

#### **Robust Cascading of Operations on Polyhedra**

We present an algorithm for robustly implementing sequences of operations on polyhedra. We modify the input to each operation by rounding the output of the previous operation to floating point, randomly perturbing, and ensuring that the result represents a polyhedron. We demonstrate our algorithm on a packing algorithm with ten cascaded Minkowski sums and set operations.

Elisha Sacks Purdue University eps@cs.purdue.edu

<u>Victor Milenkovic</u> University of Miami vjm@cs.miami.edu

#### CP0

Self-Overlapping Curves: Analysis and Applica-

When a 2D disk is stretched arbitrarily with possible selfoverlaps, without twisting, its boundary forms a complex curve known as a self-overlapping curve. The mapping between the disk and its deformed self, also called the disk immersion, is useful in many applications like shape morphing and curve interpretation. Given a self-overlapping curve, an algorithm for computing its immersion is presented, which has an average time complexity quadratic in the number of points on the curve.

#### Uddipan Mukherjee

University of California, Irvine umukherj@ics.uci.edu

#### $\mathbf{CP0}$

#### Electromagnetic Control of Charged Particulate Spray Systems - Models for Planning the Spray-Gun Operations

This work concerns the use of externally applied electromagnetic fields in charged particulate spray systems. We present a set of simple physical and geometric arguments for identifying the mapping between spray-gun trajectory and the target surface - along with the parametric dependence of the mapping on operation parameters and the applied fields - and illustrating their role in constructing physically based process simulations. Sensitivity to process parameters is also characterized for a given applied field.

Debanjan Mukherjee, Tarek Zohdi University of California, Berkeley debanjan@berkeley.edu, zohdi@me.berkeley.edu

#### CP0

#### Automated Fixture Configuration for Rapid Manufacturing Planning

Practical fixture configuration largely remains an experience driven manual activity to enable customization for varying workpiece geometry, and most automated solutions do not scale well to accommodate such variation. In this pape, we address the problem of rapidly synthesizing a realistic fixture that will guarantee stability and immobility of a specified polyhedral work-part. The paper addresses both theoretical and practical issues in 3D fixturing and makes contributions to both. Many examples are shown.

Saigopal Nelaturi Palo Alto Research Center, nelaturi@parc.com

Arvind Rangarajan, Christian Fritz, Tolga Kurtoglu Palo Alto Research Center (PARC) arangara@parc.com, cfritz@parc.com, tolga.kurtoglu@parc.com

#### $\mathbf{CP0}$

#### A Unified Method for Hybrid Subdivision Surface Design Using Geometric Partial Differential Equations

This research presents a novel technique to evaluate the finite element basis functions and the first attempt for constructing GPDE subdivision surface with hybrid control meshes consisting of triangles and quadrilaterals. We choose the mean curvature flow and Willmore flow as our driven GPDEs, and the finite element method coupled with a hybrid Loop and Catmull-Clark subdivision algorithm as the numerical simulation method.

#### Qing Pan

Key Laboratory of High Performance Computing and Stochastic Info Processing, Hunan Normal University, Changsha, China panqing@lsec.cc.ac.cn

Guoliang Xu Academia Sinica Beijing, China xuguo@lsec.cc.ac.cn

Yongjie Zhang Department of Mechanical Engineering Carnegie Mellon University jessicaz@andrew.cmu.edu

#### CP0

## Linear Algebraic Representation for Topological Structures

We advocate that a proper mathematical model for all topological structures is a (co)chain complex: a sequence of (co)chain spaces and (co)boundary mappings. This implies all topological structures may be represented by a collection of sparse matrices. We propose a Linear Algebraic Representation (LAR) scheme and show that it supports variety of topological computations using standard matrix algebra, without any overhead in space or running time. Full open source implementation of LAR is now available.

Antonio DiCarlo Università Roma Tre adicarlo@mac.com

<u>Alberto Paoluzzi</u> Roma Tre University paoluzzi@dia.uniroma3.it

Vadim Shapiro University of Wisconsin - Madison vshapiro@engr.wisc.edu

#### CP0

#### Geometric Interoperability with Queries

The problem of geometric (model and system) interoperability is conceptualized as a generalization of the problem of part interchangeability in mechanical assemblies. Interoperability subsumes the problems of geometric model quality, exchange, interchangeability, and system integration. Most interoperability proposals have been datacentric. Instead, we advocate a query-centric approach that can deliver interoperable solutions to many common geometric tasks in computer aided design and manufacturing, including model acquisition and exchange, metrology, and computer aided design/analysis integration.

Chris Hoffmann Dep't Computer Science, Purdue University Lafayette, IN cmh@cs.purdue.edu Vadim Shapiro University of Wisconsin - Madison vshapiro@engr.wisc.edu

Vijay Srinivasan NIST vijay.srinivasan@nist.gov

#### CP0

## Kinematic Skeleton Extraction from 3D Articulated Models

We propose a kinematic skeleton extraction method from an articulated 3D model. Our method is a hybrid approach combining the advantages of topology-based and geometry-based methods using the Morse theory and the shape descriptor. This method does not require manuallychosen feature points or markers, is independent of both postures and the number of branches in the model, and can efficiently extract kinematic skeletons that can be directly applied to the character rigging.

Jaehwan Ma, Sunghee Choi, Jeong-Ho Son KAIST, Daejeon, Daejeon, South Korea mapaeowl@gmail.com, sunghee@kaist.edu, n/a

#### CP0

#### GaFinC: Gaze and Finger Control Interface for 3D Model Manipulation in CAD Application

We propose an improved gesture control interface for 3D modeling manipulation tasks that possesses conventional interface level usability with low user fatigue while maintaining a high level of intuitiveness. By analyzing problems associated with previous hand gesture controls in translating, rotating and zooming, we developed a multi-modal control interface called GaFinC. GaFinC can track precise hand position and recognize several finger gestures and utilizes an independent gaze pointing interface for setting the point of interest.

Junbong Song Seoul National University, Seoul junbong.song@gmail.com

Sungmin Cho, Seung-Yeob Baek, Kunwoo Lee, Hyunwoo Bang Seoul National University sungmins@snu.ac.kr, bsy86@snu.ac.kr, Kunwoo@snu.ac.kr, savoy@snu.ac.kr

#### CP0

#### High-Quality Vertex Clustering for Surface Mesh Segmentation Using Student-t Mixture Model

In order to robustly perform segmentation for industrial objects measured by a 3-D scanning device, we propose a new method for high-quality vertex clustering on a noisy mesh. Using Student-t mixture model with the variational Bayes approximation, we develop a vertex clustering algorithm in the 9-D space composed of three kinds of principal curvature measures along with vertex position and normal component. We demonstrate effectiveness of our method by applying it to real-world scanned data.

<u>Shoichi Tsuchie</u>, Tikara Hosino Nihon Unisys, Ltd. shoichi.tsuchie@unisys.co.jp, chikara.hoshino@unisys.co.jp Masatake Higashi Design Engineering Laboratory TOYOTA TECHNOLOGICAL INSTITUTE higashi@toyota-ti.ac.jp

#### CP0

#### Puzzhull: Cavity and Protrusion Hierarchy to Fit Conformal Polygons

We present a simple definition for, and a method to find, cavities and protrusions of a 2D polygon. These geometric features are then used to find fitting polygons, as in the case of jigsaw puzzle, which in a general case is NP-hard.

Shanaz Mistry, <u>Niranjan U N</u>, M. Gopi University of California, Irvine shanaz.mistry@gmail.com, un.niranjan@uci.edu, gopi@ics.uci.edu

#### $\mathbf{CP0}$

#### An Optimization Approach for Constructing Tri-Variate B-Spline Solids

We present an approach that automatically constructs a trivariate tensor-product B-spline solid via a gradientbased optimization approach. Given six boundary B-spline surfaces for a solid, this approach finds the internal control points so that the resulting trivariate B-spline solid is valid in the sense the minimal Jacobian of the solid is positive. It further minimizes a volumetric functional to improve resulting parametrization quality. Our approach employs elastic deformation, constraint aggregation, divideand-conquer and hierarchical optimization techniques.

Xilu Wang, Xiaoping Qian Illinois Institute of Technology xwang136@hawk.iit.edu, qian@iit.edu

#### CP0

#### How the Beast Really Moves: Cayley Analysis of Mechanism Realization Spaces Using CayMos

For a commonly occurring subclass of 1-dof treedecomposable linkages in 2D, we give a canonical bijective representation and visualization of the connected components of the Euclidean realization space, as curves in a carefully chosen Cayley parameter space. This also allows us to find a shortest "distance" between connected components. By implementation of these results in our new software CayMos, we give new observations about the realization spaces of many well-studied 1-dof linkages including the Strandbeest.

Meera Sitharam Computer and Information Science University of Florida sitharam@cise.ufl.edu

Menghan Wang University of Florida menghan@cise.ufl.edu

#### CP0

#### Geometric Computation and Optimization on Tolerance Dimensioning

An efficient geometric method of tolerance analysis is presented for optimizing dimensioning and providing an optimal processing plan for a discrete part. A topological graph is introduced to represent the geometric primitives and dependencies in dimensioning. The tolerance zone is obtained by translating parametric models into corresponding geometric computations. Geometric optimization is applied to the graph in order to find the optimal dimensioning scheme. Applications include tolerance analysis, dimension scheme optimization, and process planning.

Songgang Xu, John Keyser Texas A&M University sxu@tamu.edu, keyser@cs.tamu.edu

#### $\mathbf{CP0}$

#### A Parallel Algorithm for Improving the Maximal Property of Poisson Disk Sampling

This paper presents a simple yet effective algorithm to improve an arbitrary Poisson disk sampling to reach the maximal property. Our algorithm has a natural parallel structure and is memory efficient and flexible that can generate maximal Poisson disk sampling in an arbitrary 2D polygon or 3D polyhedron. Furthermore, it can be extended from Euclidean space to curved surfaces in an intrinsic manner, which distinguishes itself from other parallel Poisson disk sampling techniques.

Xiang Ying, Zhenhua Li, Ying He Nanyang Technological University ying0008@ntu.edu.sg, yhe@ntu.edu.sg

#### CP0

#### Optimizing Polycube Domain Construction for Hexahedral Remeshing

Polycube mapping can provide regular and global parametric representations for general solid models. Automatically constructing effective polycube domains, however, is challenging. We present an algorithm for polycube construction and volumetric parameterization. The algorithm has three steps: pre-deformation, polycube construction and optimization, and mapping computation. Compared with existing polycube mapping methods, our algorithm can robustly generate desirable polycube domain shape and lowdistortion volumetric parameterization. It can be used for automatic high-quality hexahedral mesh generation.

 Wuyi Yu, Kang Zhang, Shenghua Wan, Xin Li

 Louisiana State University

 wuyiyu@lsu.edu,

 kzhang4@tigers.lsu.edu,

 swan2@cct.lsu.edu, xinli@lsu.edu

#### $\mathbf{CP0}$

#### A Simple and Local Method for Computing Teichmller Map on 3D Surfaces

We present a simple yet effective technique to compute Teichmller map on surfaces of non-trivial topology. Our method extends the linear Beltrami solver from the complex plane to manifold setting: it computes the local Tmap on the local coordinate chart and then diffuses the map through the entire mesh. Our method is linear, local, easy to implement and has a very natural parallel structure. Furthermore it requires neither numerical solver nor the global coordinate system.

Minqi Zhang, Ying He Nanyang Technological University mzhang1@ntu.edu.sg, yhe@ntu.edu.sg

#### CP0

#### **Continuous Penetration Depth**

We present a new measure for computing continuous penetration depth between two intersecting rigid objects. Our algorithm guarantees that both the penetration depth magnitude and direction are continuous with respect to the motion parameters. We have applied our algorithm to complex rigid models composed of tens or hundreds of thousands of triangles and the runtime query takes only around 0.01 milliseconds.

Xinyu Zhang Univ. of North Carolina at Chapel Hill zhangxy@cs.unc.edu

Young J. Kim Ewha Womans University, Korea kimy@ewha.ac.kr

Dinesh Manocha University of North Carolina, Chapel Hill dm@cs.unc.edu

#### CP1

## Geometric Characteristics of Quadric Bézier Triangular Patches

We derive expressions for implicit equations of quadric Bézier triangular patches in terms of their control nets and weights, and also for the tangent planes to the quadric. This allows us to use control nets and weights to classify quadrics and to derive expressions for their geometric characteristics (centers, vertices, axes...)

Alicia Cantón Universidad Politécnica de Madrid alicia.canton@upm.es

Leonardo Fernández-Jambrina Universidad Politecnica de Madrid leonardo.fernandez@upm.es

Eugenia Rosado María, María Jess Vázquez Gallo Universidad Politécnica de Madrid eugenia.rosado@upm.es, mariajesus.vazquez@upm.es

#### CP1

#### Aesthetic Spiral Design With Control Points

This paper elucidates the properties of Generalized Log-Aesthetic Curves (GLAC) for CAD practicalities. It is an extension of the emerging Log-Aesthetic (LA) curve with an extra DoF encompassing clothoid, circle involute, logarithmic spiral and etc. The first section analyzes the bounds of GLAC and identifies the occurrence of inflection points based on DoFs ( $\nu$ ,  $\Lambda$  and  $\alpha$ ). The second section describes the algorithm to generate GLAC interactively with three control points. The final section verifies the superiority of GLAC by depicting drawable regions of GLAC and comparing them to LA curves.

Rudrusamy Gobithaasan Dept. of Mathematics, FST, Univeristy Malaysia Terengganu gr@umt.edu.my Ramamoorthy Karpagavalli Dept. of Mathematics, FST, University Malaysia Terengganu, Malaysia. karpa85@hotmail.com

Kenjiro Miura Graduate School of Science & Technology, Shizuoka University, Japan. tmkmiur@ipc.shizuoka.ac.jp

## CP1

Fair Bi-4 Surfaces

The construction fills multi-sided neighborhoods in a bi-3 spline complex. Guide surfaces and a novel splitting of  $G^1$  constraints consistently yield fair highlight distribution, even for input with extreme curvature variation.

<u>Kestutis Karciauskas</u> Vilnius University Kestutis.Karciauskas@mif.vu.lt

Jorg Peters University of Florida jorg@cise.ufl.edu

#### $\mathbf{CP1}$

#### Volume-Oriented Tangential Redistribution of Points on Evolving Manifolds

We present a method that can be used for improving the mesh quality of evolving discretized manifolds. The method is based on a specifically designed tangential redistribution of points during the evolution process. We formulate the results in a general continuous setting and then we demonstrate the performance of our method on the special case of mean curvature flow of surfaces in  $\mathbb{R}^3$ . We show how we can obtain an asymptotically uniform mesh with respect to the area of mesh elements or how we can preserve relative volumes of mesh elements during the evolution.

<u>Mariana Remesikova</u>, Karol Mikula, Peter Sarkoci Slovak University of Technology remesikova@math.sk, mikula@math.sk, sarkoci@math.sk

Daniel Sevcovic Comenius University, Bratislava sevcovic@fmph.uniba.sk

#### CP1

## Complete Log-Aesthetic Surfaces by Logarithmic Helical Sweep

We propose a new category of aesthetic surfaces, called complete log-aesthetic surfaces, all of whose isoparametric curves are log-aesthetic curves. Log-aesthetic curves are curves with linear logarithmic curvature graphs, and such linearity has been confirmed in many existing aesthetic curves. Complete log-aesthetic surfaces are generated by sweeping a log-aesthetic curve segment along a logarithmic helix, a special case of log-aesthetic space curves. Some features of the surfaces, such as Gaussian curvature, are presented.

Kenji Shikano, Takafumi Saito

Tokyo University of Agriculture and Technology 50012401214@st.tuat.ac.jp, txsaito@cc.tuat.ac.jp

Norimasa Yoshida Nihon University norimasa@acm.org

#### CP1

#### Selective Degree Elevation for Multi-Sided Bezier Patches

This work presents a method to selectively elevate the degree of multi-sided Bézier patches of arbitrary dimension over any domain without self-intersections. Users selectively insert control points of higher degree while maintaining the polynomial reproduction order of the original patch. This elevates the degree of desired portions of the patch adding degrees of freedom and maintaining continuity with adjacent patches without elevating the degree of the entire patch, avoiding creation of unnecessary degrees of freedom.

Jason Smith, Scott Schaefer Texas A&M University agjdsmith09@gmail.com, schaefer@cs.tamu.edu

#### $\mathbf{CP2}$

#### Modeling of Countercurrent Two-Phase Interacting Flows: A Geometric Approach

A number of chemical engineering unit operations involve two-phase countercurrent flows brought into contact. Mathematically, this type of system can be representated by a hyperbolic conservation law with two dependent variables. If the equilibrium between the two phases is attained instantaneously, a constraint equation must also be considered. Furthermore, if a chemical reaction occurs in one of the phases, the conservation law becomes inhomogeneous. The paper will focus on construction and classificaton of the steady-state solutions that may occur depending on the geometry of the constraint curve, which is frequently not convex (usual assumption in analysis of conservation laws).

Dmitry A. Altshuller Dassault Systemes altshuller@ieee.org

#### CP2 On-Line Reconstruction of 3d Geometry

In reverse engineering and computer-aided design (CAD) applications point cloud data is usually manually acquired, reconstructed, and post-processed in separated steps. The operator of a hand-held laser scanner has no feedback from the reconstruction results. On-line reconstruction of 3d geometry allows for such an immediate feedback. Regions where the scanned data is insufficient for the reconstruction can be detected on the fly to allow an immediate correction. This enables the operator to focus on critical regions in the scanned data to improve the reconstruction quality. This talk focuses on on-line segmentation and reconstruction of basic geometric primitives. The presented methods allow for an interactive processing of a point stream. These methods feature data structures that can be updated at any time if additional data from the stream has to be processed. This data is used to complete and improve the segmentation and reconstruction during the scanning process.

<u>Klaus Denker</u> HTWG Konstanz kdenker@htwg-konstanz.de

#### CP2

## Uniformly Triangulated Minimal Surfaces in Architecture

We present novel method for finding minimal surfaces with application in design of triangular shell structures in architecture. Our method is based on mean cutvature flow of initial triangulated surface with boundary to a minimal surface. The flow of the surface in normal direction is accompanied by an originally designed tangential redistribution of points on evolving surface which causes uniform discretization of selected curves forming the surface triangulation.

Karol Mikula, Martin Huska, Matej Medla, Peter Novysedlak, Mariana Remesikova Slovak University of Technology mikula@math.sk, huska.martin2@gmail.com, matej.medla@gmail.com, novysedlak.peter@gmail.com, marianarem@gmail.com

#### CP2

## Physical Models and Simulation in Procedural Modeling

Models of hydraulic erosion have to account for the dynamic conditions present in a variety of physical systems. However, synthesis of erosion features by simulation suggests a way of reducing the diversity of the underlying models by emphasizing principles of self-organization, such as emergent behavior and avalanching. For a concrete illustration, I will discuss the role of self-organization in the development of several models of erosion with applications in terrain generation.

Alex Pytel, Stephen Mann Cheriton School of Computer Science University of Waterloo apytel@uwaterloo.ca, smann@uwaterloo.ca

#### CP2

#### Earthquake Modeling with Lévy Processes

A new earthquake model using a Levy driven stochastic processes will be discussed. Assuming variance of the process is an Ornstein-Uhlenbeck type process this will lead to the Barndorff-Nielsen and Shephard (BN-S) model for earthquake data. Improvement over the previous related results will be discussed. This model has potential geoscientific applications in estimating earthquakes in certain regions.

Indranil Sengupta Department of Mathematics North Dakota State University indranil.sengupta@ndsu.edu

#### CP2

#### Adaptive Vehicle Make Design Performance Verification through Physics-based Simulation

DARPAs Adaptive Vehicle Make (AVM) program is developing extensive design, analysis, and production software and is building a production line to support the goal of greatly reducing vehicle development time (see VehicleForge.org). We describe how the conceptual through detailed designs are analyzed to confirm performance to achieve correct by construction. This includes automatic meshing of CAD geometries for physics-based simulations. The first vehicle that rolls off the production line is intended to be fully operational.

James D. Walker, Sidney Chocron, Michael Moore, Greg Willden, Charles Anderson Southwest Research Institute james.walker@swri.org, sidney.chocron@swri.org, michael.moore@swri.org, greg.willden@swri.org, charles.anderson@swri.org

John Riegel R3 Technologies, Inc. jriegel@r3-technology.com

David Riha, John McFarland Southwest Research Institute david.riha@swri.org, john.mcfarland@swri.org

Ryan Alberson, David Stevens Protection Engineering Consultants ralberson@protection-consultants.com, dstevens@protection-consultants.com

#### CP3

## Adaptive Meshes for Realistic Tokamaks Geometries Using IsoGeometric Analysis

Designing realistic and exact geometries for actual tokamaks is an important step for studying and understanding non-linear MHD and kinetic models. We are interested in adaptive meshes as part of an r-adaptive strategy for solving partial differential equations with evolving internal structure, such as those encountered in non-linear MHD and Kinetic models. In particular, flux aligned meshes are used for the equilibrium state, while equidistributed meshes are used for high anisotropic diffusion problems, ELMs simulations and strong turbulence.

<u>Ahmed Ratnani</u> CEA ahmed.ratnani@cea.fr

Virginie Grandgirard C.E.A/DSM/IRFM Cadarache virginie.grandgirard@cea.fr

Eric Sonnendrucker Max-Planck Institute of Plasmas Physics Garching eric.sonnendrucker@ipp.mpg.de

#### CP3

#### Shape Design and Isogeometric Analysis over An Arbitrary Parametrization Using Mapped Basis Functions

This talk presents a novel method for shape design and isogeometric analysis from a quadrilateral control mesh of arbitrary topology using mapped basis functions. Based on an arbitrary input quadrilateral control mesh, a global parametrization of the final surface is first defined through a Gravity Center Method (GCM). A re-parametrization method is then applied to map a given basis function to others tailored to each of the control vertices which can be either regular or extraordinary ones. The final surface is defined by all the input control vertices with their corresponding mapped basis functions patch by patch. Depending on the continuity of the original basis function used for mapping to others, the global continuity of the resulting surface, including at extraordinary positions, can be of an arbitrarily higher order. In this talk, a uniform cubic B-spline basis function is used to illustrate the method and the resulting surface is globally  $C^2$  continuous. Several examples are provided to demonstrate the proposed method for both shape design and isogeometric analysis. Other basis functions can also be used for mapping purpose and the method can also be extended to non-quadrilateral control meshes.

Xiaoyun Yuan, Weiyin Ma City University of Hong Kong xyuan9@student.cityu.edu.hk, mewma@cityu.edu.hk

#### CP3

## Hierarchies Generated by Nested Generating Systems

In order to provide the possibility of local refinement, several generalizations of tensor-product splines have been explored, such as hierarchical splines. We consider a generalized hierarchical spline space which is based on a nested sequence of (possibly linearly dependent) generating systems, such as box-splines. We analyze the properties of the space obtained by collecting functions with respect to a decreasing sequence of hierarchical domains and explore applications in geometric design and isogeometric analysis.

#### Urska Zore

Johannes Kepler University, Linz Institute for Applied Geometry urska.zore@jku.at

Bert Juettler Johannes Kepler University of Linz Institute of Applied Geometry bert.juettler@jku.at

#### CP4

#### Parameterization-Aware Mip-Mapping

We present a method of generating mipmaps that takes into account the distortions due to the parameterization of a surface. Our method downsamples warped textures by assigning texels weights proportional to their area on a surface and filters textures for best reproduction by the postfilter used on the GPU. Our method improves texture filtering but only modifies mipmap generation, requires no modification of art assets or rasterization algorithms, and does not affect run-time performance.

<u>Josiah M. Manson</u>, Scott Schaefer Texas A&M University josiahmanson@gmail.com, schaefer@cs.tamu.edu

#### $\mathbf{CP4}$

#### Topologically Informed, Geometrically Robust Molecular Visualization

Synchronous dynamic visualizations of bio-molecular simulations are crucial 0-th order analyses for the Big Data generated. Reliable visualization depends upon topological guarantees so that domain scientists do not draw unwarranted inferences. Responsive numerical techniques on the underlying spline models, inclusive of rigorous error bounds, are presented for high performance computing environments.

<u>Thomas J. Peters</u>, Hugh Cassidy University of Connecticut tpeters@engr.uconn.edu, hugh.cassidy@uconn.edu

Kirk E. Jordan IBM T.J. Watson Research kjordan@us.ibm.com

#### $\mathbf{CP4}$

#### Using Adaptive Composite B-Spline Grid Generation to Enhance 3D Web Visualizations

We describe an adaptive grid generation technique based on the composition of tensor product B-spline mappings,  $\mathbf{T}$  and  $\boldsymbol{\Phi}$ , where  $\boldsymbol{\Phi}$  maps the unit square onto itself and  $\mathbf{T}$  maps the unit square onto the desired physical domain. Variational methods are used to adjust the  $\mathbf{T}$  and  $\boldsymbol{\Phi}$  coefficients to move grid points without disturbing the accuracy of the boundary approximation. The effectiveness of the method on both convex and nonconvex domains is demonstrated. Applications to the development of computational grids for the rendering of complex mathematical function surfaces on the web are shown.

Bonita V. Saunders National Institute of Standards and Technology (NIST) bonita.saunders@nist.gov

#### CP5

## Nonlinear Diffusion Filtering of Data on the Earth's Surface

We present data filtering based on a numerical solution of linear and nonlinear diffusion equations on closed surfaces, namely on the Earth's surface. The Earth is approximated by a polyhedral surface created by planar triangles and we construct a dual co-volume grid. On the co-volumes we define a weak formulation of the problem by applying Green's theorem to the Laplace-Beltrami operator. Then we introduce a surface finite-volume method to discretize the weak formulation. In case of nonlinear diffusion we use the regularized surface Perona-Malik model. In our numerical experiments we reduce noise from the GOCE satellite mission observations and from the mean dynamic topography over oceans.

#### Robert Cunderlik

Dept. of Mathematics, Slovak University of Technology Bratislava, Slovakia cunderli@svf.stuba.sk

Karol Mikula Slovak University of Technology mikula@math.sk

#### CP5

#### Mesh Denoising Via L0 Minimization

We present an algorithm for denoising triangulated models based on L0 minimization. Our method maximizes the flat regions of the model and gradually removes noise while preserving sharp features. As part of this process, we build a Lei He, Scott Schaefer Texas A&M University leih@cs.tamu.edu, schaefer@cs.tamu.edu

#### $\mathbf{CP5}$

#### Laplace Inversion of Lr-Nmr Relaxometry Data Using Sparse Representation Methods

LR-NMR relaxometry is a powerful tool that can be harnessed for characterizing constituents in complex materials. Conversion of the relaxation signal into a continuous distribution of relaxation components is an ill-posed problem. We provide a numerical optimization method for analyzing LR-NMR data by including L1 regularization and applying a convex optimization solver PDCO. Our integrated approach includes validation of analyses by simulations, testing repeatability of experiments, and validation of the model and its statistical assumptions. The proposed method provides better resolved and more accurate solutions compared to those suggested by existing tools.

<u>Ofer Levi</u> Ben-Gurion University of the Negev Beer-Sheva, Israel levio123@gmail.com

Paula Berman, Yisrael Parmet Ben-Gurion University of the Negev bermansh@gmail.com, iparmet@bgu.ac.il

Michael A. Saunders Systems Optimization Laboratory (SOL) Dept of Management Sci and Eng, Stanford saunders@stanford.edu

Zeev Wiesman Ben-Gurion University of the Negev wiesman@bgu.ac.il

#### $\mathbf{CP5}$

#### Balloon Darts: Fast Approximate Union Volume in High Dimensions with Line Samples

We approximate the volume of the union of *d*-dimensional balls. Deterministic, exact approaches are too slow for high dimensions. We adapt these to sampling balls with randomly-oriented lines through their centers: pop balloons by spoke darts. We compare the efficiency to Monte Carlo and Bringmann and Friedrich's pointsampling methods. A line sample works well because it gives more information than a point sample and is almost as fast.

<u>Scott A. Mitchell</u>, Mohamed S. Ebeida Sandia National Laboratories samitch@sandia.gov, msebeid@sandia.gov

#### CP5

#### Adaptively Weighted Numerical Integration over

#### **Arbitrary Domains**

For a given set of quadrature points and order of integration, the weights are obtained by solving a system of suitable moment equations in least square sense. The computed weights adapt to the geometry of the domain allowing accurate integration over variety of non-traditional, imprecise, or non-conforming representations without excessive subdivision, which is useful in many applications including meshfree analysis. Experimental results indicate that adaptively weighted integration compares favorably with more traditional domain decomposition approaches.

#### Vaidyanathan Thiagarajan

Spatial Automation Laboratory University of Wisconsin Madison vthiagarajan@wisc.edu

Vadim Shapiro University of Wisconsin - Madison vshapiro@engr.wisc.edu

#### $\mathbf{MS1}$

#### **Trends in Geometric Representations**

For the past 20 years or so, there has been little change in the set of techniques used to represent geometry in commercial CAD/CAM/CAE systems. However, some new approaches are being stimulated by hardware changes and by convergence with the game/entertainment industries. This talk examines some possible changes and their consequences.

George Allen Siemens PLM Software george.allen@siemens.com

#### ${\bf MS1}$

#### New Challenges in Isogeometric Analysis

Numerous papers illustrate the superiority of Isogeometric Analysis (IgA) compared to traditional Finite Element Analysis for many problems. However, so far the use of IgA in industry is limited. We will address different causes for this slow uptake of IgA in industry, and address possible actions and activities needed for speeding up the uptake of IgA.

#### <u>Tor Dokken</u>

SINTEF ICT, Department of Applied Mathematics Oslo, Norway tor.dokken@sintef.no

#### $\mathbf{MS1}$

#### Geometric Modeling with Convolutions

Modern engineering design with laminated, composite materials makes challenging demands of geometric modeling and processing systems, and complex products such as the Boeing 787 add to the difficulty. While a complete solution to these challenges is still many years away, progress has been made addressing some of the issues. One promising technique has been applying convolution operators to build high quality geometry models. Early experiments suggest that many interesting and powerful convolution-based geometric constructions are possible.

Thomas A. Grandine Applied Mathematics The Boeing Company thomas.a.grandine@boeing.com

#### $\mathbf{MS1}$

#### **Challenges in Geospatial Applications**

The talk will present challenges in handling and visualizing the information hidden in large heterogeneous geospatial data sets. It is based on the work in the on-going European project "IQmulus: a high-volume fusion and analysis platform for geospatial point clouds, coverages and volumetric data sets". This four-year project addresses the definition, configuration and deployment of functional spatial processing services for test cases in marine spatial planning and land applications for rapid responses and territorial management.

Ewald Quak Institute of Cybernetics Tallinn, Estonia Ewald.Quak@cs.ioc.ee

#### MS2

#### Challenges in Simulation based Engineering

Simulations have become an essential part in the engineering process. Currently many different simulation models are used to ensure the desired characteristics of an object (product or production site) on virtual prototypes. The increase in computing power and new technologies allows to advance the separated model islands towards a digital twin that accompanies the whole lifecycle of the object. In this talk the challenges and profits of the digital twin are discussed from an industry point of view.

<u>Stefan Boschert</u> Siemens AG stefan.boschert@siemens.com

#### MS2

#### Challenges for Geometric Design

Abstract not available at time of publication.

### <u>Elaine Cohen</u>

University of Utah cohen@cs.utah.edu

#### $\mathbf{MS2}$

#### Challenges in the Building Industry

The construction of advanced architectural designs is presently a very labour intensive and costly process. It is therefore limited to a few prestige projects and it is a major challenge to the building industry to bring the cost down and thereby offer architects more variability in the economically feasible designs – allow them to think out of the box. To address this challenge "The Danish National Advanced Technology Foundation' has supported the "BladeRunner' project that involves several Danish companies and public institutions. It aims to reduce the amount of manual labor by applying robots to cut EPS-moulds for concrete using the Hot Wire or Hot Blade technology. The mathematical challenge is to rationalise the architects' CAD drawings into surfaces that can be created by these technologies.

#### <u>Jens Gravesen</u> Technical University of Denmark

jgra@dtu.dk

#### $\mathbf{MS2}$

## Efficient Geometry: Compositions and a Good Parametrization

My crystal ball has me anxious for two advances in geometric modeling: effective use of compositions of functions and practical algorithms for "good" geometry parametrization. The intersection of a surface and a curve on a surface is a geometric object given by function composition-the curve is a function into the parameter space of the surface. Finding the intersection means solving a system of equations involving compositions, which has not been widely investigated. Geometry parametrizations, on the other hand, have been extensively studied (cf., e.g., FloaterHormann2005). This and similar capabilities have many uses in geometry for manufacturing. But it is still difficult to make effective use of the existing methods.

Thomas A. Hogan The Boeing Math Group thomas.a.hogan@boeing.com

#### MS3

#### LR B-splines

Starting from a tensor product B-spline basis collections of LR B-splines and a corresponding LR-mesh are generated in a sequence of successive local refinements. Such refinements must split the support of at least one B-spline. The approach applies equally well in higher dimensions. To check for linear independence the "peeling algorithm" can be used, or alternatively each refinement must be "handin-hand" and generating just the number of B-splines necessary to span the spline space.

#### Tor Dokken

SINTEF ICT, Department of Applied Mathematics Oslo, Norway tor.dokken@sintef.no

#### MS3

#### **Hierarchical T-Splines**

Hierarchical B-splines were originally introduced in the CAD community nearly thirty years ago. Currently, hierarchical spline techniques are restricted to tensor product B-splines and NURBS. This restriction, coupled with the difficulty of encoding geometric information in the hierarchy, has greatly hampered their adoption as a CAD tool. To overcome these limitations we have extended analysis-suitable T-splines to the hierarchical unstructured regime. In this way, the design advantages of T-splines can be leveraged while introducing the analysis advantages of easily controlled hierarchies of locally refined analysis-suitable T-spline spaces. We present a simple characterization and construction for hierarchical analysis-suitable T-splines and demonstrate their potential as a basis for adaptive isogeometric analysis.

Emily Evans Maths Department Brigham Young University ejevans@math.byu.edu

Michael Scott Civil and Environmental Engineering Brigham Young University michael.scott@byu.edu

Derek C. Thomas Brigham Young University Dept. of Physics and Astronomy dthomas@byu.edu

#### MS3

## LR B-Splines and Adaptive Refinement in Fluid Mechanics

Locally Refinable (LR) B-splines represent a novel approach to local refinement within isogeometric analysis. In this work we present numerical investigations of the use of LR B-splines for isogeometric analysis of flow problems. The problems considered are governed by the steady-state, incompressible Navier-Stokes equations in two dimensions. We propose a set of LR B-spline discretizations of the velocity and pressure fields, and we investigate their stability and convergence properties through representative examples.

#### Peter Nørtoft

Techical University of Denmark penn@dtu.dk

#### MS3

#### **Isogeometric Spline Forests**

In this talk we present isogeometric spline forests. An isogeometric spline forest is a hierarchical spline representation posed over a surface or volume of arbitrarily complex geometry and topological genus. Spline forests can accomodate arbitrary degree and smoothness in the underlying hierarchical basis as well as non-uniform knot interval configurations. We describe adaptive h-refinement and coarsening algorithms for isogeometric spline forests and demonstrate their potential in the context of several demanding analysis problems.

<u>Michael Scott</u> Civil and Environmental Engineering Brigham Young University michael.scott@byu.edu

Derek C. Thomas Brigham Young University Dept. of Physics and Astronomy dthomas@byu.edu

Emily Evans Maths Department Brigham Young University ejevans@math.byu.edu

#### MS4

#### Curve Topology Certification Problems Arising in Geodesy: Transforming 3D Cartesian Coordinates To Geodetic Coordinates

Closed form solutions for transforming 3D Cartesian to geodetic coordinates reduce the problem to finding the real solutions of the fourth degree latitude equation or variations of it. By using curve topology certification techniques for algebraic curves defined implicitely we characterize completely the region where Vermeille's approach, the most popular analytical method dealing with this problem, can not be applied. Moreover we introduce a new method for solving the latitude equation for those cases not covered by Vermeille's approach.

Laureano Gonzalez-Vega Universidad de Cantabria Dpto. Matematicas, Estadistica y Computacion laureano.gonzalez@unican.es

#### $\mathbf{MS4}$

## Algebraic and Analysic Results for Truncated Hierarchical B-Splines

The interest in hierarchical techniques for tensor-product splines has increased recently due to the need for adaptive refinement in numerical simulation via isogeometric analysis. The newly introduced truncated hierarchical B-spline (THB) basis of hierarchical splines possesses several advantageous properties, such as partition of unity, increased sparsity and improved stability. The talk will report recent results concerning completeness, stability, approximation power and implementation aspects of THB splines.

<u>Bert Juettler</u> Johannes Kepler University of Linz Institute of Applied Geometry bert.juettler@jku.at

Carlotta Giannelli Johannes Kepler University Linz Austria carlotta.giannelli@jku.at

#### $\mathbf{MS4}$

#### Collision-Detection and Distance-Related Computations for Freeform Geometric Models

Abstract not available at time of publication.

Myung-Soo Kim School of Computer Science and Engineering Seoul National University, Korea mskim@snu.ac.kr

#### $\mathbf{MS4}$

#### Free-Form Shape Modeling with Cyclides Splines

We discuss how to model free-form shapes using fair and smooth cyclide splines, which are composed of Dupin cyclide patches possibly with T-joints and singularities. We overcome the inflexibility of cyclide patches by relaxing their corner vertices in a constrained optimization framework. We show test results in surface fitting and shape modeling, thus presenting the cyclide spline as a practical free-form surface representation with the exact offset property.

Pengbo Bo Harbin Institute of Technology, China bob\_pengbo@163.com

Wenping Wang University of Hong Kong Department of Computer Science wenping@cs.hku.hk

#### $\mathbf{MS5}$

## From Design to Production: The TERRIFIC Demonstrator Part

The TERRIFIC project covers the whole process from early design over numerical simulation towards manufacturing. Using the TERRIFIC Demonstrator Part it will be shown how isogeometry contributes during these phases of the design and manufacturing process. This includes general methods and guidelines for the design of isogeometrical friendly geometries and their segmentation into topological volumes as basis for the trivariate spline volume generation and isogeometric analysis. Having done the analysis, the machining of the part is supported, utilizing isogeometric techniques for better control and efficiency in the machining process.

#### Stefan Boschert

Siemens AG stefan.boschert@siemens.com

#### MS5

#### Parametrization for Eigenvalue Problems in Isogeometric Analysis

In this talk, comprehensive schemes are described to construct rational trivariate solid T-splines from boundary triangulations. For arbitrary topology objects, we first compute a smooth harmonic scalar field defined over the mesh and saddle points are extracted to determine the topology. By dealing with the saddle points, a polycube whose topology is equivalent to the input geometry is built and it serves as the parametric domain for the trivariate T-spline. A polycube mapping is then used to build a one-to-one correspondence between the input triangulation and the polycube boundary. After that, we choose the deformed octree subdivision of the polycube as the initial T-mesh, and make it valid through pillowing, quality improvement and applying templates to handle extraordinary nodes and partial extraordinary nodes. The obtained T-spline is C2continuous everywhere over the boundary surface except for the local region surrounding polycube corner nodes.

#### Jens Gravesen

Technical University of Denmark jgra@dtu.dk

#### $\mathbf{MS5}$

#### Advances of the Meccano Method for Isogeometric Analysis of Irregular Planar Domains

We present advances of the meccano method for T-spline modelling and analysis of complex geometries. We consider a planar domain composed by several irregular subdomains. These sub-regions are defined by their boundaries and can represent holes or different materials. The bivariate T-spline representation of the whole physical domain is constructed from a square. In this procedure, a T-mesh optimization method is crucial. We show results of an elliptic problem by using a quadtree local T-mesh refinement technique.

José Iván López González, Marina Brovka, José María Escobar Sánchez SIANI University of Las Palmas de Gran Canaria jilopez@siani.es, mbrovka@siani.es, jmescobar@siani.es José Manuel Cascón Barbero Department of Economics and History of Economics University of Salamanca casbar@usal.es

Rafael Montenegro Armas SIANI University of Las Palmas de Gran Canaria, Spain rafa@dma.ulpgc.es

#### $\mathbf{MS5}$

#### Volumetric Isogeometric Descriptions Or Isogeometric Modeling of Complex Geometries

In this talk, comprehensive schemes are described to construct rational trivariate solid T-splines from boundary triangulations. For arbitrary topology objects, we first compute a smooth harmonic scalar field defined over the mesh and saddle points are extracted to determine the topology. By dealing with the saddle points, a polycube whose topology is equivalent to the input geometry is built and it serves as the parametric domain for the trivariate T-spline. A polycube mapping is then used to build a one-to-one correspondence between the input triangulation and the polycube boundary. After that, we choose the deformed octree subdivision of the polycube as the initial T-mesh, and make it valid through pillowing, quality improvement and applying templates to handle extraordinary nodes and partial extraordinary nodes. The obtained T-spline is C2continuous everywhere over the boundary surface except for the local region surrounding polycube corner nodes.

Yongjie Zhang Department of Mechanical Engineering Carnegie Mellon University jessicaz@andrew.cmu.edu

#### $\mathbf{MS6}$

## Planar Shape Interpolation with Bounded Distortion

Planar shape interpolation is widely used in computer graphics applications. Despite a wealth of interpolation methods, there is currently no approach that produces shapes with a bounded amount of distortion with respect to the input. As a result, existing interpolation methods may produce shapes that are significantly different than the input and can suffer from fold-overs and other visual artifacts, making them less useful in many practical scenarios. We introduce a novel shape interpolation scheme designed specifically to produce results with a bounded amount of conformal (angular) distortion. Our method is based on an elegant continuous mathematical formulation and provides several appealing properties such as existence and uniqueness of the solution as well as smoothness in space and time domains. We further present a discretization and an efficient practical algorithm to compute the interpolant and demonstrate its usability and good convergence behavior on a wide variety of input shapes. The method is simple to implement and understand. We compare our method to state-of-the-art interpolation methods and demonstrate its superiority in various cases.

Renjie Chen Technion - Israel Institute of Technology Haifa renjie.c@gmail.com University of Haifa weber@cs.haifa.ac.il, dkeren@cs.haifa.ac.il

Mirela Ben-Chen Technion - Israel Institute of Technology, Israel mirela@cs.technion.ac.il

#### MS6

#### Locally Injective Mappings

Mappings and deformations are ubiquitous in geometry processing, shape modeling, and animation. Numerous deformation energies have been proposed to tackle problems like mesh parameterization and volumetric deformations. We present an algorithm that modifies any deformation energy to guarantee a locally injective mapping, i.e., without inverted elements. Our formulation can be used to compute continuous planar or volumetric piecewise-linear maps and it uses a barrier term to prevent inverted elements. Differently from previous methods, we carefully design both the barrier term and the associated numerical techniques to be able to provide immediate feedback to the user, enabling interactive manipulation of inversion-free mappings. Stress tests show that our method robustly handles extreme deformations where previous techniques converge very slowly or even fail. We demonstrate that enforcing local injectivity increases fidelity of the results in applications such as shape deformation and parameterization.

Christian Schüller ETH Zurich, Switzerland schuellc@inf.ethz.ch

Ladislav Kavan University of Pennsylvania, USA ladislav.kavan@gmail.com

Daniele Panozzo ETH Zurich daniele.panozzo@gmail.com

Olga Sorkine-Hornung ETH Zurich, Switzerland sorkine@inf.ethz.ch

#### MS6

#### Hierarchical Deformation of Locally Rigid Meshes

We propose a method for calculating deformations of models by deforming a low-resolution mesh and adding details while ensuring that the details we add satisfy a set of constraints. Our method builds a low-resolution representation of a mesh by using edge collapses and performs an as-rigid-as-possible deformation on the simplified mesh. We then add back details by reversing edge-collapses so that the shape of the mesh is locally preserved. While adding details, we deform the mesh to match the predicted positions of constraints so that constraints on the fullresolution mesh are met. Our method operates on meshes with arbitrary triangulations, satisfies constraints over the full-resolution mesh, and converges quickly.

Josiah M. Manson, <u>Scott Schaefer</u> Texas A&M University josiahmanson@gmail.com, schaefer@cs.tamu.edu

#### $\mathbf{MS6}$

#### **Bijective Composite Mean Value Mapping**

We introduce the novel concept of composite barycentric mappings and give theoretical conditions under which they are guaranteed to be bijective. We then focus on mean value mappings and derive a simple procedure for computing their Jacobians, leading to an efficient GPU-assisted implementation for interactively designing composite mean value mappings which are bijective up to pixel resolution. We provide a number of examples of 2D image deformation and an example of 3D shape deformation based on a natural extension of the concept to spatial mappings.

<u>Teseo Schneider</u> Universita della Svizzera Italiana teseo.schneider@usi.ch

Kai Hormann University of Lugano kai.hormann@usi.ch

Michael Floater University of Oslo Centre of Mathematics for Applications michaelf@ifi.uio.no

#### MS7

## Isogeometric Analysis with Discontinuous Garlerkin Method

We discuss solving numerical PDEs with discontinuous Garlerkin(DG) method. The domain is represented by NURBS patches, and Isogeometric Analysis approach is proposed to solve the PDEs. Stability and convergence analysis are performed. Examples are provided to illustrate the convergence of the method.

#### <u>Falai Chen</u>

Department of Mathematics University of Science and Technology of China chenfl@ustc.edu.cn

#### $\mathbf{MS7}$

#### Conservation of Geometry and Physics in Numerical Modeling of Incompressible Flow

The incompressible Navier-Stokes equations are infused with important physical structure, evidenced by an array of balance laws for momentum, energy, enstrophy, and helicity. In this talk, I will discuss a class of spline-based discretizations that automatically replicate this structure and, through the isogeometric concept, extend to arbitrary NURBS and T-spline mapped geometries. Numerical examples illustrating the promise of this new technology will be presented.

John Evans, Thomas Hughes Institute for Computational Engineering and Sciences The University of Texas at Austin john.a.evans@colorado.edu, hughes@ices.utexas.edu

#### MS7

Spline Spaces over Rectangle Meshes with Com-

#### plex Topologies

We present a new type of spline functions defined over a rectangular mesh equipped with an equivalence relation, in such a way that physical spaces with a complex topology can be represented as an homomorphic image of such meshes. We provide general definitions, a dimension formula for a subclass of these spline spaces, an explicit construction of their bases and also a process for local refinement. These developments, motivated by plane curvilinear mesh constructions are illustrated on several parametrization problems. Our main target in these constructions is to approximate isobaric lines of magnetic fields encountered in MHD simulation for Tokamaks. Their particularity is that one of the isobaric curve has a node singularity.

Andre Galligo Mathematics, Université Nice Sophia Antipolis and Galaad team, INRIA. galligo@math.unice.fr

Bernard Mourrain, Meng Wu INRIA Sophia Antipolis Bernard.Mourrain@inria.fr, meng.wu@inria.fr

#### MS7

#### Spline Forests for Discrete Differential Forms

We discuss our initial results for the construction of sequences of discrete differential forms from a forest of spline trees. Forests of spline trees allow arbitrary topologies to be represented by hierarchical splines while the discrete differential forms preserve the underlying geometric structure. This approach combines exact representation of geometry with a structure preserving basis that permit local h-refinement. Requirements for compatible forests and structure-preserving hierarchical h-refinement are also considered. The integration of these features with Bezier extraction is presented and the results are applied to benchmark problems.

Derek C. Thomas Brigham Young University Dept. of Physics and Astronomy dthomas@byu.edu

Michael Scott Civil and Environmental Engineering Brigham Young University michael.scott@byu.edu

Rafael Vazquez IMATI CNR Pavia, Italy vazquez@imati.cnr.it

John A. Evans Department of Aerospace Engineering Sciences University of Colorado at Boulder john.a.evans@colorado.edu

#### MS8

#### Extended Graph Rotation Systems and Its Applications to Modeling 2-Manifolds, Woven Surfaces and 3-Manifolds

In this talk, I will start to demonstrate extended graph rotation systems using rectangular paper strips that correspond to 2D thickened edges of a 2-manifold mesh. I will show how insert edge operation change the topology of orientable surfaces. I will also how edge twist operation creates non-orientable surfaces. My next demonstration will be in forming knots in 3-space by finger-traversing the boundary of the faces of non-orientables. I will show some of the results we have achieved in recent years using this basic concept. I will then demonstrate that this approach has a potential to describe 3-manifolds that can help our understanding and modeling 3-manifold structures. I expect that such a generalized 3-manifold mesh representations can be used in modeling solids, architectural shapes, high-genus surfaces, knots and links. For 3-manifolds, I will start with prisms that represents 3D thickened edges of 3-manifold meshes and discuss what kind of models can be constructed using those prisms. I will introduce the concepts of chambers and blocks. Using boundary walk I will demonstrate the faces of 3-manifolds can be both one and two-sided. If we want duality, this suggests that 3D thickened edges should also be one or two-sided and 3D thickened vertex boundaries can be any 2-manifold.

Ergun Akleman Texas A&M ergun.akleman@gmail.com

#### $\mathbf{MS8}$

#### Symmetric Surfaces and Tilings

Abstract not available at time of publication.

<u>Konrad Polthier</u> Freie Universitaet Berlin FB Mathematik & Informatik konrad.polthier@fu-berlin.de

#### $\mathbf{MS8}$

## Shape Optimization for Human-Centric Products with Standardized Components

In this talk, we present an optimization framework for automating the customization of human-centric products, which can be mounted on or embedded in human body (such as exoskeletal devices and implants). Such products need to be customized to fit the body shapes of users. At present, the procedure of customization is taken in an interactive manner that is inefficient. We investigate a method to automate the procedure of customization. The major difficulty in solving this problem is that we cannot freely vary the shape of every component. Many of them should be selected from the serialized standard components. Different from the existing approaches that need to fabricate all components by customized production, we develop a new method to generate customized products by using asmany-as-possible standardized components. Our work is based on a mixed-integer shape optimization framework for design automation with standardized components.

#### Charlie Wang

The Chinese University of Hong Kong, China cwang@mae.cuhk.edu.hk

#### MS8 Modeling Cmc Surfaces with Cvt

Abstract not available at time of publication.

Wenping Wang University of Hong Kong Department of Computer Science wenping@cs.hku.hk

#### $\mathbf{MS9}$

#### Verification of Mechanical Engineering Finite Element Analysis

The objective is to obtain a posteriori estimate of the discretization error of a reference problem solved using the finite element analysis. Different techniques are presented. The proposed method is particularly suited to industrial common situations. It can be used in the case where some data may be missing and can be applied to very large problem within a accessible CPU time.

Eric Florentin LMT-Cachan France eric.florentin@lmt.ens-cachan.fr

Sylvain Pavot LMT-Cachan (France) pavot@lmt.ens-cachan.fr

Laurent Champaney Arts et Metiers PARISTECH laurent.champaney@ensam.eu

#### MS9

#### Exploiting Components Interfaces and Functional Information to Generate FE Models of Assemblies

Using the geometric interfaces information (contacts, interferences, clearances) extracted from the relative 3D location of assembly components, this approach describes how functional information can be derived and tightly linked to an assembly model. This representation is then used to identify repetitive configurations and transform adequately an assembly for FE analysis. Idealization is one of the key transformations which is addressed through a new and robust modeling trees of volume objects specifically derived for this transformation.

<u>Jean-Claude Leon</u> University of Grenoble / INRIA Grenoble, France jean-claude.leon@grenoble-inp.fr

#### MS9

#### From CAD to 3-Variate Spline Representation: The Terrific-Part

The creation of 3-variate spline models suited for IgA is a major game stopper when trying to introduce IgA in industry. This process is illustrated starting from a CAD-representation of the TERRIFIC demo part: IGA suitable models are created in a process including changing the surface patch structure, 3-variate block structuring, reparametrization and possibly approximation of block boundary surfaces, and the final creation of 3-variate watertight spline modes.

#### Vibeke Skytt

SINTEF ICT, Department of Applied Mathematics Oslo, Norway vibeke.skytt@sintef.no

#### PP1

#### Geometrical-Computational Inverse Methods for Optimal Geometrical Deformation of Lumbar Artificial Disks Using the Numerical Reuleaux Method

Lumbar artificial implants and disks experience material deformations during the rather big biomechanical loads that are acting on the lumbar spine, e.g., flexion or extension. During this biomechanical process the disks move around an Instantaneous Rotation Center (IRC), which is related to the bending moment of the implant and other physical-geometrical variables. By using the inverse geometrical algorithms of the Numerical Reuleaux Method, it is possible to select the desirable IRC and link it to the material contact mechanics and geometrical-variation parameters such as stress and strain. We present the geometrical/computational analysis of this group of formulation and carry out mathematical simulations and examples for sharp understanding.

#### Francisco Casesnoves

ASME (American Society Mechanical Engineering) (Individual Researcher Affiliated. Physicist) mathematics88@gmx.com

#### PP1

Finite Element Geometric Modeling of Traumatic Brain Injury for the Inverse Localization of Electrical Brain Activity Recorded Using Electroencephalography

The combined use of CT, MRI and EEG is demonstrated to (1) perform geometric modeling of the human head via the finite element method (FEM), (2) implement inverse localization of electrical activity recorded from severe traumatic brain injury (TBI) patients, and (3) inversely localize cortical generators responsible for epileptiform discharges. Ignoring pathology-related conductivity changes is found to cause substantial inaccuracies in inverse localization. Insight provided by this framework can play a beneficial role in patient recovery.

<u>Andrei Irimia</u> UCLA andrei.irimia@loni.ucla.edu

Sheng-Yang Goh, Carinna Torgerson, Micah Chambers, Nathan Stein, Jeffry Alger, Paul Vespa University of California, Los Angeles n/a, n/a, n/a, n/a, n/a

Ron Kikinis Harvard Medical School n/a

John Van Horn University of California, Los Angeles n/a

#### PP1

## Redevelopment of Coastline Model for Procedural Modeling

An abstract view of coastline erosion permits modeling it as a sequence of discrete events occurring at the land-ocean interface. Furthermore, the system's dynamic behavior, as proposed by Sapoval, can be described with a relationship between the coast's length and the erosion force. However, simulations of the conceptual model differ, particularly in how they calculate the coast's perimeter. After implementing several simulations, I describe a re-definition of the underlying model for procedural modeling applications.

#### Alex Pytel

Cheriton School of Computer Science University of Waterloo apytel@uwaterloo.ca

Stephen Mann University of Waterloo Cheriton School of Computer Science smann@uwaterloo.ca

#### PP1

## Bladerunner: Surface Rationalisation for HotWire and HotBlade Technology

On a small scale, Milling and 3D-printing are used in producing prototypes of geometric objects. For fast large-scale production, the HotWire and HotBlade technologies could instead produce building elements by cutting out moulds for concrete. The standard use of B-spline based CAD systems then entails the need for rationalization. Thus, a spline surface has to be segmented and each piece approximated by a surface that can be produced by the HotWire and HotBlade.

Toke B. Nørbjerg, Kasper Steenstrup, Jens Gravesen, David Brander, Andreas Brentzen Technical University of Denmark tono@dtu.dk, khor@dtu.dk, jgra@dtu.dk, dbra@dtu.dk, janba@dtu.dk

#### $\mathbf{PP1}$

# $\mathbb{C}^2$ Quasi Arc-length Polynomial Approximation to Curves

Transcendental curves, or those resulting from offsetting, are not rational and must be hence approximated to incorporate them into commercial systems. We present a systematic polynomial approximation, based on piecewise Hermite interpolation with  $C^2$  quasi arc-length parameterization, a desirable property for robotics or CNC. We consider two alternatives (piecewise Bzier quintics and cubic B-splines), whose control points turn out to display very simple geometry. Finally, we compare our results with those from existing methods.

Javier Sanchez-Reyes, Jesus Chacon Universidad de Castilla-La Mancha, Spain IMACI, ETS Ingenieros Industriales Javier.SanchezReyes@uclm.es, jesusmiguel.chacon@uclm.es

#### $\mathbf{PP1}$

#### Protrusion Recognition from Solid Models Using Orthogonal Bounding Factor

When a loop of concave edges is an inner loop on a single face, it is a strong hint of existence of protrusion feature and recognition of the protrusion face is straightforward. However, when a protrusion feature lies on multiple faces, it is bounded by a loop of concave edges that are not on a single face. In such cases, the rule of inner loop is no more available and recognition of protrusion faces becomes unclear. In order to address this problem, a new quantitative measure, named Orthogonal Bounding Factor (OBF), is introduced in this paper. Mathematically, OBF is defined as the sum of cross products of two consecutive vectors normal to a set of faces, and it physically represents the possibility of being a protrusion in a solid model. The formal definition of orthogonal bounding factor is established and a method to recognize protrusion features using OBF is presented.

<u>Yoonhwan Woo</u> Hansung University yhwoo@hansung.ac.kr

# Notes

# GD/SPM13 Speaker and Organizer Index



November 11-14, 2013 the Curtis–a DoubleTree by Hilton Hotel Denver, Colorado, USA

Italicized names indicate session organizers.

# A

Akleman, Ergun, MS8, 9:30 Tue Allen, George, IP6, 8:00 Thu Allen, George, MS1, 4:15 Mon Allen, George, PD1, 6:30 Tue Altshuller, Dmitry A., CP2, 3:45 Wed

## B

Bedregal, Carlos, PS3, 4:25 Mon Ben-Chen, Mirela, IP3, 2:00 Tue *Ben-Chen, Mirela, MS6, 3:45 Wed* Boschert, Stefan, MS2, 8:30 Tue Boschert, Stefan, PD1, 6:30 Tue Boschert, Stefan, MS5, 4:15 Wed Boussuge, Flavien, PS6, 9:50 Wed Busé, Laurent, PS2, 11:10 Mon

## С

Casesnoves, Francisco, PP1, 6:00 Mon Chen, Renjie, MS6, 4:45 Wed Cherin, Nicolas, PS4, 8:20 Tue Cohen, Elaine, MS2, 9:30 Tue Cohen, Elaine, PD1, 6:30 Tue Cunderlik, Robert, CP5, 10:30 Thu

## D

Dekkers, Ellen, PS6, 10:15 Wed Denker, Klaus, CP2, 4:05 Wed Dokken, Tor, MS1, 4:45 Mon Dokken, Tor, MS3, 10:30 Tue Dokken, Tor, MS3, 10:30 Tue Dokken, Tor, MS5, 3:45 Wed Dokken, Tor, MS7, 10:30 Thu Dokken, Tor, MS9, 2:00 Thu

## E

Ebeida, Mohamed S., PS6, 9:25 Wed Elber, Gershon, PS4, 8:40 Tue Evans, Emily, MS3, 11:00 Tue Evans, John, MS7, 11:30 Thu

## F

Fernández-Jambrina, Leonardo, CP1, 10:30 Tue Florentin, Eric, MS9, 3:00 Thu

## G

Galligo, Andre, MS7, 11:30 Thu Gobithaasan, Rudrusamy, CP1, 10:50 Tue *Gonzalez-Vega, Laureano, MS4, 10:30 Tue* Gonzalez-Vega, Laureano, MS4, 12:00 Tue Grandine, Thomas A., MS1, 3:45 Mon Grandine, Thomas A., PD1, 6:30 Tue Gravesen, Jens, MS2, 8:00 Tue Gravesen, Jens, PD1, 6:30 Tue Gravesen, Jens, MS5, 5:15 Wed

## Η

Hahmann, Stefanie, PS1, 10:15 Mon Hanniel, Iddo, PS5, 4:20 Tue He, Lei, CP5, 10:50 Thu Hogan, Thomas A., MS2, 9:00 Tue Hogan, Thomas A., PD1, 6:30 Tue

Imbach, Rémi, PS5, 3:55 Tue Irimia, Andrei, PP1, 6:00 Mon

### J Jaxon, Noah, PS2, 11:35 Mon Juettler, Bert, MS4, 10:30 Tue

### K Kara, Levent Burak, PS4, 9:20 Tue Karciauskas, Kestutis, CP1, 11:10 Tue Kim, Myung-Soo, MS4, 11:30 Tue Kim, Myung-Soo, IP4, 8:00 Wed Kim, Yong-Joon, PS3, 5:05 Mon

## Leon, Jean-Claude, MS9, 2:00 Thu Levi, Ofer, CP5, 11:10 Thu Lipson, Hod, IP1, 8:00 Mon

## Μ

Mann, Stephen, PP1, 6:00 Mon Manson, Josiah M., CP4, 9:05 Thu McMains, Sara, PS7, 12:00 Wed Mikula, Karol, CP2, 4:45 Wed Milenkovic, Victor, PS3, 3:45 Mon Mitchell, Scott A., CP5, 11:30 Thu Montenegro Armas, Rafael, MS5, 4:45 Wed Mukherjee, Debanjan, PS4, 9:40 Tue

Mukherjee, Uddipan, PS3, 4:05 Mon

## Ν

Natarajan, Vijay, IP5, 2:15 Wed Nelaturi, Saigopal, PS1 9:50 Mon Nørbjerg, Toke B., PP1, 6:00 Mon Nørtoft, Peter, MS3, 11:00 Tue

## Ρ

Pan, Qing, PS2, 12:00 Mon Panozzo, Daniele, MS6, 3:45 Wed Paoluzzi, Alberto, PS3, 5:25 Mon Peters, Thomas J., CP4, 9:25 Thu *Polthier, Konrad, MS8, 8:00 Tue* Polthier, Konrad, MS8, 8:00 Tue Pytel, Alex, CP2, 4:25 Wed

## Q

Quak, Ewald, MS1, 3:45 Mon Quak, Ewald, MS1, 5:15 Mon Quak, Ewald, MS2, 8:00 Tue

**R** Ratnani, Ahmed, CP3, 9:05 Thu Remesikova, Mariana, CP1, 11:30 Tue

## S

Sanchez-Reyes, Javier, PP1, 6:00 Mon Saunders, Bonita V., CP4, 9:45 Thu Schaefer, Scott, MS6, 5:15 Wed Schneider, Teseo, MS6, 4:15 Wed Scott, Michael, MS3, 10:30 Tue Scott, Michael, MS3, 12:00 Tue Scott, Mike, MS5, 3:45 Wed Scott, Mike, MS7, 10:30 Thu Scott, Mike, MS9, 2:00 Thu Sengupta, Indranil, CP2, 5:05 Wed Shapiro, Vadim, PS1, 9:25 Mon Shikano, Kenji, CP1, 11:50 Tue Skytt, Vibeke, MS9, 2:30 Thu Smith, Jason, CP1, 12:10 Tue Son, Jeong-Ho, PS4, 8:00 Tue Song, Junbong, PS4, 9:00 Tue

## T

Thiagarajan, Vaidyanathan, CP5, 11:50 Thu Thomas, Derek C., MS7, 10:30 Thu Tsuchie, Shoichi, PS7, 11:35 Wed

## U

U N, Niranjan, PS3, 4:45 Mon

## W

Walker, James D., CP2, 5:25 Wed Wang, Charlie, MS8, 9:00 Tue Wang, Menghan, PS5, 4:45 Tue Wang, Wenping, MS4, 8:30 Tue *Wang, Wenping, MS8, 8:00 Tue* Wang, Wenping, MS8, 11:00 Thu Wang, Xilu, PS2, 12:25 Mon Woo, Yoonhwan, PP1, 6:00 Mon

## Х

Xu, Songgang, PS1, 9:00 Mon

## Υ

Ying, Xiang, PS7, 11:10 Wed Yu, Wuyi, PS6, 9:00 Wed Yuan, Xiaoyun, CP3, 9:25 Thu

## Ζ

Zhang, Minqi, PS7, 12:25 Wed Zhang, Xinyu, PS5, 3:30 Tue Zhang, Yongjie, MS5, 3:45 Wed Zore, Urska, CP3, 9:45 Thu

# Notes

# GD/SPM13 Budget

## Conference Budget SIAM Conference on Geometric and Physical Modeling November 11-14, 2013 Denver, CO

Expected Paid Attendance		150	
Revenue			
Registration Income		_	\$55,310
	Total	_	\$55,310
Expenses			
Printing			\$800
Organizing Committee			\$1,900
Invited Speakers			\$13,000
Food and Beverage			\$8,600
AV Equipment and Telecommunication			\$7,900
Advertising			\$8,000
Conference Labor (including benefits)			\$31,153
Other (supplies, staff travel, freight, misc.)			\$7,100
Administrative			\$8,042
Accounting/Distribution & Shipping			\$5,643
Information Systems			\$7,687
Customer Service			\$2,895
Marketing			\$4,705
Office Space (Building)			\$3,157
Other SIAM Services		_	\$3,521
	Total		\$114,103
Net Conference Expense			(\$58,793)
Support Provided by SIAM			\$58,793
		_	\$0
Estimated Support for Travel Awards not included above:			
Post Docs and Students		4	\$2,900

# the Curtis-a Doubletree by Hilton Hotel

