

Graphics **Interface** 2015

Halifax, Nova Scotia

3 – 5 June 2015

Proceedings

Edited by

Hao (Richard) Zhang
Tony Tang



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President's Welcoming Letter



Canadian Human-Computer Communications Society /
Société canadienne du dialogue humain-machine

Paul G. Kry
School of Computer Science
McGill University, Canada

The Canadian Human-Computer Communications Society (CHCCS) / Société Canadienne du Dialogue Humaine Machine (SCDHM) is a non-profit organization dedicated to advancing research and education in computer graphics, visualization, and human-computer interaction. The primary activity of CHCCS/SCDHM is sponsoring the annual Graphics Interface conference, the longest-running regularly scheduled conference on interactive computer graphics. In most years, Graphics Interface is held as part of a larger suite of conferences. This year the AI/GI/CRV 2015 conference, encompassing Artificial Intelligence and Computer and Robotic Vision along with Graphics Interface, is located in Halifax, Nova Scotia. The conference promises to be an excellent event, with a selection of high quality papers in computer graphics, visualization, and human-computer interaction, accompanied by a lively posters and demo session featuring late breaking ideas and work in progress.

In addition to its annual conference, CHCCS/SCDHM sponsors several awards. The annual Michael A.J. Sweeney Award recognizes best student papers presented at the conference. The annual Alain Fournier Dissertation Award and the Bill Buxton Dissertation Award recognize the best Ph.D. dissertations awarded in Canada during the previous year for computer graphics and human-computer interaction, respectively. The annual CHCCS/SCDHM Achievement Award is presented to a Canadian who has made substantial research contributions to computer graphics, visualization, or human-computer interaction. The CHCCS/SCDHM Service Award is presented to a Canadian who has rendered substantial service contributions to the society or to the research community. Each year the Awards Committee receives nominations and selects a winner of the Achievement Award and, from time to time, a winner of the Service Award. The current committee is chaired by Marilyn Tremaine, Rutgers University, and has as members Kellogg Booth, University of British Columbia, and Brian Wyvill, University of Victoria. I thank the Awards committee for their efforts in finding a very well-deserving recipient. Nominations for the Alain Fournier Award and Bill Buxton Award are due mid-February of each year, and the winners are selected by independent committees coordinated by Pierre Poulin. I am very grateful to Pierre and the members of the respective committees for their work in identifying the top dissertations of 2013. The Michael A.J. Sweeney Award winners are selected by the program co-chairs in consultation with the program committee. Finally, for the first time in 2015 the CHCCS/SCDHM will be sponsoring and hosting the Canadian Digital Media Pioneer awards which were initiated by GRAND NCE in 2011.

The Annual General Meeting of CHCCS/SCDHM is held every year during the Graphics Interface conference, to review the previous year's activities and elect the executive committee. Current members of the executive committee are

- Paul Kry, McGill University, president
- Pierre Poulin, Université de Montréal, vice president
- Michael McGuffin, École de Technologie Supérieure, treasurer
- William Cowan, University of Waterloo, past president
- Derek Reilly, Dalhousie University, editor-in-chief
- James Stewart, Queen's University, web master

All Graphics Interface attendees are invited to attend the General Meeting, or to contact any member of the executive committee about CHCCS/SCDHM. I encourage everyone interested in the future of Graphics Interface to attend and get involved. Recent activities include the creation of a publicly available archive of the proceedings from early years, and a new web site. Since 2012, top graphics papers at Graphics Interface have been invited to submit extended versions to a special section of Computers & Graphics, and there are ongoing efforts to find a journal with which we can do the same for the top papers in the area of human-computer interaction.

On behalf of the society, and of all those who have worked to put on this year's conference, I extend a warm welcome to all the attendees of AI/CRV/GI 2015. I wish to thank this year's co-chairs, Tony Tang and Richard Zhang, along with the committee members and referees for all their hard work in creating the conference program. And most important, I wish to thank all the authors who submitted their research. Without their commitment there would be no conference.

Preface

A Message from the Program Chairs

GRAPHICS COCHAIR

Hao (Richard) Zhang
Simon Fraser University, Canada

HCI COCHAIR

Tony Tang
University of Calgary, Canada

Graphics Interface is the oldest continuously-scheduled conference in computer graphics and human-computer interaction. The conference dates back to 1969, when it was the “Canadian Man-Computer Communications Seminar”, changing its name in 1982 to Graphics Interface. This year is Graphics Interface’s 41st year, and it takes place in Halifax, Nova Scotia from June 3rd to 5th.

The program for Graphics Interface 2015 features 35 papers. We received 57 (HCI) + 34 (Graphics) submissions. Among these high-quality submissions, we were able to accept 22 papers from the HCI track (38%), and 13 papers 38% from the Graphics track.

The program committee comprised 28 experts from Graphics and HCI. Each paper was formally reviewed by two committee members, at least two external reviewers, and often received informal reviews from more. A fully double-blind reviewing process was used: the identity of the paper authors was known only to the program committee chairs and to the primary committee member assigned to the submission. We thank the program committee and the external reviewers for ensuring rigor and integrity in the reviewing process.

The Michael A. J. Sweeney Award will be awarded at the conference to the best student papers in graphics and HCI. This year, NVIDIA, Microsoft Research and Intel have kindly sponsored Graphics Interface with prizes for best papers and best poster.

Since 2012, authors of selected top papers in graphics have been invited to submit extended and revised manuscripts to be considered, with partial reviewer continuity, for journal publication in a special section of *Computers & Graphics*. We look forward to seeing the final extended versions of these selected papers later this year in the special section on graphics interaction.

We are proud to include keynote talks from two invited speakers, one Achievement Award winner, and two dissertation award winners. The two invited speakers, Shahram Izadi (Microsoft Research) and Doug James (Cornell) are both well known for their exemplary contributions to their disciplines. Our congratulations to Scott MacKenzie (York University), this year’s recipient of the recipient of the CHCCS/SCDHM Achievement Award. We also congratulate the two dissertation award winners, Michelle Annett (University of Alberta) -- 2014 Bill Buxton Dissertation Award, and James McCrae (University of Toronto) -- 2014 Alain Fournier Dissertation Award.

We are excited this year to introduce the Graphics Interface Speaker Series, sponsored in part by Microsoft Research. We have seven speakers this year, each with an exemplary track record, and a leader in his or her respective fields: Christopher Batty (University of Waterloo), Wilmot Li (Adobe Systems), Regan Mandryk (University of Saskatchewan), Joanna McGrenere (University of British Columbia), Ryan Schmidt (Autodesk Research), Daniel Wigdor (University of Toronto), and Jianxiang Xiao (Princeton University).

We would like to thank various people who contributed to the behind-the-scenes conference organization, especially Pierre Poulin, Kelly Booth, Marilyn Tremaine, and Meghan Haley. Thanks also go out to Tibi Popa, the poster chair, Pawan Lingras, the AI/GI/CRV general chair, and local organizers Sageev Oore and Jason Rhineland. Lastly, we owe a great debt to James Stewart and Precision Conference Solutions for handling the electronic submission and review system; James’s patience and responsiveness made the process run as smoothly as we could have hoped.

For further information about the conference series, you can visit the official web site, <http://www.graphicsinterface.org>

Organization

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Simon Fraser University, Canada

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Michael A. J. Sweeney Award 2015



Canadian Human-Computer Communications Society /
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The CHCCS/SCDHM honours the memory of Michael A. J. Sweeney through an annual award to the best student papers presented at each year's Graphics Interface conference. The winning papers selected by the program committee, one graphics paper and one HCI paper, are chosen from among accepted papers that have a student as lead author and for which one or more student authors are presenting the paper.

Best Student Papers 2015

In Memory
Michael A. J. Sweeney, 1951-1995

Graphics 2015 Award Winner

"Visibility Sweeps for Joint-Hierarchical Importance Sampling of Direct Lighting for Stochastic Volume Rendering" by Thomas Kroes, Martin Eisemann, and Elmar Eisemann.

BIOGRAPHIES

Thomas Kroes received his bachelor degree in mechanical engineering in 2004 (Hogeschool Rotterdam, The Netherlands) and a master in industrial design engineering in 2007 (Delft University of Technology, The Netherlands). He is currently pursuing his PhD in Computer Science at Delft University of Technology (TU Delft), Netherlands. His research interests include medical visualization/simulation, GPU-accelerated stochastic volume-visualization, and realistic rendering. He is also the author of Exposure Render, an interactive photo-realistic volume rendering framework.

Martin Eisemann received a Diploma degree in Computational Visualistics from the University of Koblenz-Landau, Germany, in 2006 and his PhD degree in Computer Graphics from the TU Braunschweig, Germany, in 2011. He received the best student paper award at the annual conference of the European Association for Computer Graphics (Eurographics) in 2008. In 2011 he became Postdoctoral Researcher at the Computer Graphics Lab at the TU Braunschweig. In 2014 he spent one semester as Postdoctoral Researcher at the TU Delft. Since 2015 he is professor at the TH Köln. His main research interests include image- and video-based rendering and editing, visual analytics, and realistic and interactive rendering.

Elmar Eisemann is a professor at Delft University of Technology (TU Delft), heading the Computer Graphics and Visualization Group. Before he was an associated professor at Telecom ParisTech (until 2012) and a senior scientist heading a research group in the Cluster of Excellence (Saarland University / MPI Informatik) (until 2009).

His interests include real-time and perceptual rendering, alternative representations, shadow algorithms, global illu-

mination, and GPU acceleration techniques. He coauthored the book "Real-time shadows" and participated in various committees and editorial boards. He was local organizer of EGSR 2010, 2012 and HPG 2012, as well as co-paper chair for HPG2015 and was honored with the Eurographics Young Researcher Award 2011.

HCI 2015 Award Winner

"Penny Pincher: A blazing fast, highly accurate \$-family recognizer" by Eugene Taranta, Joseph LaViola.

BIOGRAPHIES

Eugene M. Taranta II is a Ph.D. student in the Department of Electrical Engineering and Computer Science at the University of Central Florida. He is also a staff engineer in the Cloud Systems and Solutions division at Seagate Technology. His research interests include pen-based user interfaces, gesture recognition, and computer graphics, as well as RAID coding theory, layout design, reliability, and performance. Eugene received his M.S. in Computer Science from the University of Central Florida in 2012.

Joseph J. LaViola Jr. is the CAE Link Professor and associate professor in the Department of Electrical Engineering and Computer Science and directs the Interactive Systems and User Experience Research Cluster of Excellence at the University of Central Florida. He is also an adjunct associate research professor in the Computer Science Department at Brown University. His primary research interests include pen-based interactive computing, 3D spatial interfaces for video games, human-robot interaction, multimodal interaction in virtual environments, and user interface evaluation. Joseph received a Sc.M. in Computer Science in 2000, a Sc.M. in Applied Mathematics in 2001, and a Ph.D. in Computer Science in 2005 from Brown University.

Alain Fournier Award 2014



Canadian Human-Computer Communications Society /
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On August 14th, 2000, Dr. Alain Fournier passed away. He was a leading international figure in computer graphics, and a strong and frequent contributor to the Graphics Interface conference. His insights, enthusiasm, wisdom, vast knowledge, humour, and genuine friendship touched everyone he met.

The “Alain Fournier Memorial Fund” was created to celebrate his life, to commemorate his accomplishments, and to honour his memory. It rewards an exceptional computer graphics Ph.D. dissertation defended in a Canadian University over the past year. The winning dissertation is selected through a juried process by a selection committee consisting of accomplished researchers in computer graphics.

For more information about the “Alain Fournier Memorial Fund”, and information about donation, please visit <http://grand-nce.org/graphicsinterface/awards/alain-fournier/>.



James McCrae

University of Toronto
CHCCS/SCDHM Alain Fournier
Award Recipient 2014

This year, James McCrae is the recipient of the Alain Fournier Ph.D. Dissertation Award. His dissertation, entitled Planar Section Representations of 3D Shape, made several outstanding research and commercialized contributions to 3D shape modeling, perception, and fabrication. He brings a deep scientific understanding to 3D arrangements of planar sections, previously used adhoc in art and engineering, which is timely given its applications to manufactured real materials from laser cutters and CNC routers. It is a great example of multidisciplinary research covering domains of computer graphics, shape perception, and human-computer interactions, as illustrated by his numerous publications in the top venues of these disciplines.

He has co-authored several journal and conference papers, including three papers at ACM Trans. on Graphics (SIGGRAPH and SIGGRAPH Asia), two papers at Sketch-based Interfaces and Modeling (one as best paper), one paper at ACM Trans. on Applied Perception, and several papers at various diversified conferences, including User Interface and Technology (best talk), Interactive 3D Graphics and Games, and Graphics Interface. He has already served on the program committees of the conferences Shape Modeling International, and Symposium on Applied Perception, and served regularly as referee on many publication forums. Finally, he has co-founded two companies, and filed four patents.

James completed his B.Sc., M.Sc., and Ph.D. in Computer Science, all at the University of Toronto. Professor Karan Singh was his advisor for both his M.Sc. and Ph.D.

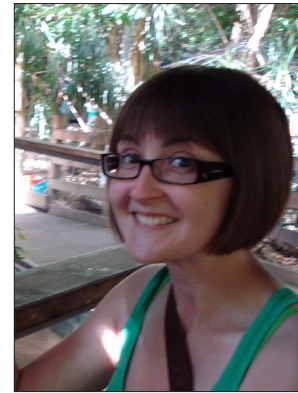
Bill Buxton Dissertation Award 2014



Canadian Human-Computer Communications Society /
Société canadienne du dialogue humain-machine

The award is named in honour of Bill Buxton, a Canadian pioneer who has done much to promote excellence, both within Canada and internationally, in the field of Human-Computer Interaction. Bill truly advocates HCI. He challenges how academics and practitioners think, and inspires them to do things differently. This is why we are proud to name this award after him.

The winning dissertation is selected through a juried process by a selection committee consisting of accomplished researchers in Human-Computer Interaction.



Michelle Annett

University of Alberta
CHCCS/SCDHM Alain Fournier
Award Recipient 2014

The recipient of the 2014 award for the best doctoral dissertation completed at a Canadian university in the field of Human-Computer Interaction is Dr. Michelle Annett.

In her dissertation, *The Fundamental Issues of Pen-Based Interaction with Tablet Devices*, she studies, with careful attention to minute details, the lack of responsiveness and accuracy with current pen-based systems for tablets and other similar devices. In her dissertation, she presents results that uncover novel end-user behaviors unique to digital pen-enabled devices and quantifies the significant impact that device latency, unintended touch, and stylus accuracy have on the digital inking experience today. She developed and studied a number of different prototypes that have the potential to make the next generation tablets as easy to use as writing on paper.

Her work is grounded in proper empirical questions and studies, and delivers a measured approach to a long-standing problem: perceived latency in pen input. The thesis presents an unpretentious, scientific view of a simple problem, without overstating its contributions or conclusions.

Michelle Annett earned her MSc and PhD in Computer Science from the University of Alberta, with a specialization in Human-Computer Interaction, under the supervision of Professor Walter F. Bischof. She has generated a large number of journal and conference publications, in well-respected HCI venues directly related to her thesis, as well as in areas outside HCI. During her graduate work, she was a research intern in the User Interface Group at Autodesk Research in Toronto, Ontario, and a visiting researcher at Microsoft Research in Redmond, Washington. Michelle is currently an NSERC Postdoctoral Fellow, holding a joint appointment in the DGP Lab at the University of Toronto with Dr. Daniel Wigdor and in the User Interface Group at Autodesk Research with Dr. Tovi Grossman and Dr. George Fitzmaurice.

Achievement Award 2015



Canadian Human-Computer Communications Society /
Société canadienne du dialogue humain-machine

The CHCCS/SCDHM Achievement Award is presented periodically to a Canadian researcher who has made a substantial contribution to the fields of computer graphics, visualization, or human-computer interaction. Awards are recommended by the CHCCS/SCDHM Awards Committee, based on nominations received from the research community. The 2015 members of the Awards Committee are Kellogg Booth, Marilyn Tremaine, and Brian Wyvill.

The 2015 CHCCS/SCDHM Achievement Award of the Canadian Human Computer Communications Society is presented to Eugene Fiume of the University of Toronto.

The recipient of this year's CHCCS Achievement Award is Professor Scott MacKenzie. With this award we recognize and acknowledge the significant contribution made by Scott over many years to the field of human-computer interaction. His impact is felt worldwide in the ISO standard his research helped establish and in input systems people use daily, whether on a laptop, a game controller, a touch screen, or a smart phone.

Scott MacKenzie holds a professorship in the Department of Electrical Engineering and Computer Science at York University which he joined after being on the faculty of Computer Science at University of Guelph. Scott began his education at Queen's University, graduating with honours in Music. Matching the typical multidisciplinary training of many human-computer interaction researchers, he then studied Electronic Engineering at Durham College and completed his education with an M.A. and Ph.D. in Education from the University of Toronto.

Very few new Ph.D.s begin their careers as successfully as Scott. His highly cited thesis has become the standard for how Fitts' Law is now used in HCI and lays the basis for much of the input device research undertaken in the field since 1991. In addition, and completely different from his HCI research, are his contributions to computer hardware. In 1992, Scott published his first book, *The 8051 Microcontroller*, which is now in its 4th edition. Four years later, he turned out his second book, *The 68000 Microprocessor*. Each book came with accompanying hardware and software to be used as teaching aides, a reflection of the type of care and consideration that Scott applies to all of his work.

Overall, Scott MacKenzie has over 160 refereed publications in top conferences and journals — three of them winning best paper awards and one an award for most cited paper in the last ten years. His research has focused on building general predictive models for how people use a variety of computer input devices: pointing devices such as the mouse, finger and stylus; scrolling devices, such as



Scott MacKenzie

York University
CHCCS/SCDHM Achievement
Award Recipient 2015

wheels and direction keys; character entry devices such as pens, virtual keyboards, one-handed keyboards; and gaze mechanisms such as eye-tracking. In all this work, he has attempted not just to run a single experiment investigating whether mechanism A works better than mechanism B, but to run a series of related studies that culminate in a general model for predicting and explaining what type of input arrangements should be designed to give the best performance for users of a given device, whether it be a game controller or a virtual keyboard. Just grab your touch pad or pull out a smart phone and start typing or pointing on it. Buried in that smooth and usable interaction you are experiencing Scott's handiwork.

Scott MacKenzie's research is responsible for the assessment methods in ISO Standard 9241-9 — Ergonomics of Human System Interaction. Beyond working on the ISO standards committee, Scott has made the standard accessible to all by developing and posting on his web site tools that implement the evaluation tests of ISO 9241-9. In addition to these tools, for anyone teaching Fitts' Law as part of their HCI curriculum, Scott has made software available for students to perform such studies. This is reflected in Scott's high teaching ratings and student praise, "... a hard course, but what a great teacher."

Adding to his books on microprocessors, Scott is the author of two additional books, one summarizing input research, *Text Entry Systems: Mobility, Accessibility, Universality*, and a second that has just been published two years ago, *Human-Computer Interaction: An Empirical Research Perspective*. Again, accompanying his recent book is software on his website to help explain the models, perform user studies, and do the statistical tests discussed in the book.

Despite his impressive contributions, Scott Mackenzie is one of the most modest researchers in the field. He is the guru of input systems and has more recently focused on how to train others in designing user studies and performing the statistical procedures needed for HCI research. All his work

is directed at service to users, to researchers, and to students. It is a pleasure to honor him with this well-deserved award.

Scott is also an avid runner (with a 2:42 marathon PB) and a dedicated family man. He has probably participated in more CHI conference fun-runs than any other researcher. He will be seen running along the Halifax shoreline before the morning sessions of Graphic Interface 2015.

Keynote Speaker

Physics-based Animation Sound: Progress and Challenges

Doug James
Cornell University



ABSTRACT

Decades of advances in computer graphics have made it possible to convincingly animate a wide range of physical phenomena, such as fracturing solids and splashing water. Unfortunately, our visual simulations are essentially “silent movies” with sound added as an afterthought. In this talk, I will describe recent progress on physics-based sound synthesis algorithms that can help simulate rich multi-sensory experiences where graphics, motion, and sound are synchronized and highly engaging. I will describe work on specific sound phenomena, and highlight the important roles played by precomputation techniques, and reduced-order models for vibration, radiation, and collision processing.

BIOGRAPHY

Doug L. James is a Full Professor of Computer Science at Stanford University since June 2015, and was previously an Associate Professor of Computer Science at Cornell University from 2006-2015. He holds three degrees in applied mathematics, including a Ph.D. in 2001 from the University of British Columbia. In 2002 he joined the School of Computer Science at Carnegie Mellon University as an Assistant Professor, before joining Cornell in 2006. His research interests include computer graphics, computer sound, physically based animation, and reduced-order physics models. Doug is a recipient of a National Science Foundation CAREER award, and a fellow of both the Alfred P. Sloan Foundation and the Guggenheim Foundation. He recently received a Technical Achievement Award from The Academy of Motion Picture Arts and Sciences for “Wavelet Turbulence,” and the Katayanagi Emerging Leadership Prize from Carnegie Mellon University and Tokyo University of Technology. He is the Technical Papers Program Chair of ACM SIGGRAPH 2015.

Keynote Speaker

The New Face of the User Interface

Shahram Izadi
Microsoft Research



ABSTRACT

For most researchers outside of the field, Human Computer Interaction (HCI) is the study and evaluation of interactive systems and techniques. While this is an important part of our discipline, nowadays HCI is as much about inventing and building the underlying technologies as it is studying their use. In this talk I will demonstrate why it is an exciting time to be a computer science researcher in this discipline. Ultimately we focus on inventing disruptive interactive technologies that are grounded by real-world problems that have direct impact on users.

The Interactive 3D Technologies (I3D) Group has been born out of this new approach to HCI research. I will demonstrate examples of projects within the group, which are all motivated by pushing the boundaries of how people can interact with computers, but doing this through technical innovation. These projects move computing beyond the mouse and keyboard into the physical world around us.

I will highlight two concrete research themes that the group is tackling. The first concerns making computers more aware of their physical environment, such that the real world can be leveraged in the digital domain. The second focuses on increasing the computer's physical understanding of the user, such that modalities such as gestures, gaze, expressions, and other aspects of human-human communication can be brought into the interface. This includes technical challenges such as developing new depth sensing technologies, real-time 3D reconstruction, detection, and tracking algorithms, and interactive 3D recognition techniques. As well as applications for augmented reality, robotics, 3D scanning and fabrication, performance capture, and so called "natural" user interfaces.

HCI has traditionally been collaborative and multi-discipline in nature, incorporating disciplines across engineering and the social sciences. I3D also values this type of multi-discipline collaborative research, but across sub-disciplines of computer science, in particular computer vision, computer graphics, machine learning, optics, and hard-

ware engineering. This talk will highlight the importance of working within this intersection point within computer science, and shows the impact on HCI, and conversely, how our research has begun to impact these sub-disciplines directly.

BIOGRAPHY

Professor Shahram Izadi is a Principal Researcher and Research Manager within Microsoft Research Redmond. He leads the Interactive 3D Technologies (I3D) group. He describes his work as: mashing together exotic sensing and display hardware with signal processing, vision and graphics algorithms to create new interactive systems, which enable users to experience computing in magical ways. His group has had many notable projects and publications to date: HoloLens, KinectFusion; RetroDepth; MotionKeyboard; Digits; Augmented Projectors; KinEtre; Vermeer; HoloDesk; Mouse 2.0; SurfacePhysics; SecondLight; and ThinSight. He was involved in a number of products including the Microsoft HoloLens, Touch Mouse, Sensor-in-Pixel, Kinect One and the Kinect for Windows SDK. Shahram has been at Microsoft Research since 2005 and prior to that spent time at Xerox PARC. He received a TR35 award in 2009 and was nominated one of the Microsoft Next in 2012.

For more information, please visit: <http://research.microsoft.com/en-us/people/shahrami/>
