Dr. Dietmar Hildenbrand  
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**Title:** Introduction to Geometric Algebra Computing

**Abstract:** In this talk, we present an introduction to “Geometric Algebra Computing”. We define it as visual development and the efficient implementation of geometrically intuitive algorithms based on Geometric Algebra for various programming languages. Geometric Algebra is a mathematical tool in order to easily compute with geometric objects, its intersections and transformations. We mainly focus on the Compass Ruler Algebra in order to deal with points, circles, lines and point pairs in 2d. We show some examples, visualize them and generate optimized code for C/C++, Matlab and Python. As an outlook we present some higher dimensional geometric algebras for the computing based on more complex Geometric objects such as conics.

**Bio:** Dr. Dietmar Hildenbrand studied computer science with mathematics at Darmstadt University, worked for many years in industry before he returned to university and made his PhD in Darmstadt with the topic “Geometric Computing in Computer Graphics and Robotics using Conformal Geometric Algebra”. Together with students he developed GAALOP, a software tool in order to generate optimized implementations of Geometric Algebra for various programming languages. He published two books “Foundations of Geometric Algebra Computing” and “Introduction to Geometric Algebra Computing”. He will be co-chair of the AGACSE (Applications of Geometric Algebra in computer science and engineering) in Brno 2021.
Title: Higher-Order Random Fields for Image Segmentation

Abstract: Energy minimization is regularly used for medical image segmentation. Higher-order energies are perhaps not as common but are nevertheless being used increasingly often. Whereas the common first-order (pairwise) potential can directly model only the relationship between pairs of pixels, the higher-order potential can model more complex and useful relationships between more than two variables. For instance, sets of pixels, chosen according to the shape to be segmented, can be encouraged to be entirely in one segment or the other by higher-order terms. This kind of enforcement of regularity across many pixels is crucial especially in medical image segmentation, where the input image is noisy but there is certain prior knowledge about shapes of organs on which we can rely. In this talk, I will describe methods for minimizing higher-order energies using graph cuts as well as some real-world examples of their applications in medical image segmentation that have been deployed in commercial medical imaging software.

Bio: Hiroshi Ishikawa has been a Professor in Computer Science and Engineering at Waseda University since 2010. He received the BS and MS degrees in mathematics from Kyoto University, and the Ph.D. degree in computer science as well as the Harold Grad Memorial Prize from the Courant Institute of Mathematical Sciences, New York University. He has been a Sakigake Researcher at the Japan Science and Technology Agency, from which he later also received a CREST grant. He received the Innovative Technologies 2016 Special Award for Culture from Japan’s Ministry of Economy, Trade and Industry, the IEEE Computer Society Japan Chapter Young Author Award in 2006, and the MIRU Nagao Award in 2009. He is on the Editorial Board of the International Journal of Computer Vision. He has been a General Chair for IAPR International Conference on Machine Vision Applications, an Associate Editor for IEEE Transactions on Pattern Analysis and Machine Intelligence, and an Area Chair for CVPR, ICCV, and ACCV. He will also be one of the Program Chairs for ACCV2020.
Prof. Dr. Christian Jacob
University of Calgary, Canada, cjacob@ucalgary.ca

Title: Immersive Story Telling about the Human Body

Bio: Dr. Christian Jacob is a Professor in the Department of Computer Science in the Faculty of Science and in the Department of Biochemistry & Molecular Biology in the Cumming School of Medicine at the University of Calgary. He serves as the Director of Bioinformatics in the Bachelor of Health Sciences program. He is also directing the LINDSAY Virtual Human project, which has won the ASTech 2015 Award for Innovations in Information and Communications Technology. He has given a TEDx Calgary talk entitled “How Video Game Engines are Changing Medical Science.”

He is also the Head of the Department of Computer Science. He has written two books on evolutionary computing and natural programming paradigms and have published more than 100 research papers.

His research interests include evolutionary computing, swarm intelligence, intuitive artificial intelligence, cinematic medicine & illustration, agent-based modelling and simulation of complex biological systems.
Prof. Dr. Xiaoyang Mao
University of Yamanashi, Japan, mao@yamanashi.ac.jp

**Title:** Arriving Light Control for Color Vision Deficiency Support Using Optical See-Through Head-Mounted Display

**Abstract:** Color vision deficiency (CVD), also known as color blindness, is commonly caused by a genetic disorder. Unfortunately, as of 2018, there is not yet a cure for the condition. Contact lenses and glasses with color filter is a possible solution to CVD with applying uniform changes to the user's field of view (FoV). On the other hand, optical see-through head-mounted displays (OST-HMD) can provide a controllable overlay to the user’s FoV, which could help for making a better solution. In this talk, I am going to introduce our project on using HMD for supporting CVD. To calibrate colors in FoV of a user with CVD, methods that often used, such as the Daltonization, need light reduce feature, which makes the calibrated color darker. However, recently commercially available OST-HMDs don't have a controllable way to decrease the brightness of incoming light. I am going to introduce an approach for light subtraction of OST-HMD using a transmissive LCD panel. A prototype system for achieving a controllable overlay to user’s FoV with OST-HMD by using scene camera, user-perspective camera, and the transmissive LCD panel will be presented. Experiments for investigating the amount of light could be decreased in every RGB channel and the range of colors which can be observed through the proposed system will also be presented.

**Bio:** Professor Xiaoyang Mao received her B.S. in Computer Science from Fudan University, M.S. and Ph.D. in Computer Science from the University of Tokyo. She is currently a professor at the Computer Science and Engineering Department, University of Yamanashi, Japan. She was a postdoctoral research fellow at the State University of New York at Stony Brook, USA during 1994 and 1995, and a visiting researcher at the computer vision laboratory of University of California at Berkeley, USA during 2004 and 2005.

She is engaged in research on computer graphics, image processing, information visualization, augmented reality. She has published more than 250 papers and 9 patents and has served as the editors of 7 books and international conference proceedings. She has served as the general or Program Committee Chairs of 8 international and domestic conferences such as Computer Graphics International 2017 and Cyberworlds 2013. She received CGI Career Achievement award in 2018. Currently, she is the member of the board of directors of Japan Arts and Sciences Society and the associate editor of The Visual Computer Journal. She is the principal investigator of several KAKENHI research projects on image processing and augmented reality technologies and their applications to e-health and data visualization.
Prof. Dr. James Parker  
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**Title:** Randomness, Art, and Computer Graphics

**Abstract:** Generative art uses computer programming and the tool of computer graphics and image processing to create visual artworks. The computer is merely the tool and does not really create the work. The artist must be willing to completely design their work in advance of the creation of it, which is unusual for an artist. Integral to this creation is the explicit use of randomness, which is implicit in most artworks of other forms. We will discuss randomness in art, using randomness for effect, and will describe ways that generative artists create their works.

**Bio:** Jim Parker has degrees in Applied Mathematics, Computer Science (M.Sc.) and Informatics (Ph.D., Universiteit Ghent with greatest distinction, 1998). He has been a Full Professor of Computer Science, a professor of Drama, and a professor of Art in a 40-year career in academia. He has published over 170 technical articles on simulation, video games, computer vision, and artificial intelligence. He is also the author of 12 books, including the most recent one “Generative Art: Algorithms as Artistic Tool”.
Prof. Dr. Khalid Saeed  
Bialystok University of Technology, Poland, k.saeed@pb.edu.pl

Title: Medical Aspects in Biometrics: Prospects and Challenges

Abstract: Biometric technologies are changing and developing fast. Over the past 10 years, a growing number of new real-world biometric technologies and techniques are replacing the most popular and commonly used human identification systems from fingerprints to voice recognition to iris scans bringing us to the time of smart life, security and comfortable life. Current modern biometric systems are flexible and capable of being consolidated into other systems. This makes Biometrics more attractive to users from different scientific areas for varieties of applications. Today, the use of Biometrics in medicine is indeed a challenge and is increasing day after day. As known to us, medicine has used biometrics since a long time ago when ECG and Computer Tomography were invented. However, nowadays modern technologies in the form of wearable devices allow for monitoring the patient biometric data remotely, exchange information with both doctors and patients as well as the form of computer-computer communication for medical applications.

Biometric-based technologies help reduce medical errors and provide high certainty degree. Examples of use cases that have been exploited within my biometric team are: Knee joint disorder recognition and automatic classification of recognized type of disorder, basing on X-ray digital image analysis; brain segmentation in order to clearly distinguish skull, brain's white matter, gray matter and tumor, and the most recent research on influence of diseases on retina recognition for human identification. We have been working on some new methodologies, the first in their kind approaches, to extract retina characteristic points for the sake of both person-identification and medical diagnosis of a human sick eye. This helps take the primary decision about illness changes. The essential challenge is to check whether the eye disease may influence the decision taken about personal identity in a biometric recognition system for security or forensics applications. This would answer the question if the person who claims of eye disease can be checked for identification by retina biometrics or not.

Bio: Khalid Saeed is a full Professor of Faculty of Mathematics and Information Science at Warsaw University of Technology, Poland. He was with AGH Krakow in 2008-2014. Computer Science in the Faculty of Computer Science at Bialystok University of Technology and Khalid Saeed received the BSc Degree in Electrical and Electronics Engineering from Baghdad University in 1976, the MSc and Ph.D. Degrees from Wroclaw University of Technology in Poland in 1978 and 1981, respectively. He received his DSc Degree (Habilitation) in Computer Science from the Polish Academy of Sciences in Warsaw in 2007. He was nominated by the President of Poland for the title of Professor in 2014. He has published more than 200 publications - edited 28 books, Journals and Conference Proceedings, 10 text and reference books. He supervised more
than 120 MSc and 15 Ph.D. theses. He gave about 45 invited lectures and keynotes in different universities in Europe, China, India, South Korea, and Japan on Biometric Image Processing and Analysis. He received about 25 academic awards. Khalid Saeed is a member of more than 15 editorial boards of international journals and conferences. He is an IEEE Senior Member and has been selected as IEEE Distinguished Speaker for 2011-2016. Khalid Saeed is the Editor-in-Chief of International Journal of Biometrics with Inderscience Publishers. As part of a national BMBF funded project, Prof. Saeed is cooperating currently with Fraunhofer IAIS in Germany in the field of cognitive engineering. He is also collaborating with Universities from Japan, India, South Korea, and Italy.
Title: Living and Playing in Virtual Reality: A few Case Studies

Abstract: In this talk, we will show how we can play individual and team sports in Virtual Reality in a natural way. We will also discuss the role in these sports of gesture recognition based on computer vision and deep learning. We will also present the technology to have multi-users in Immersive Virtual Environments using an Immersive Room and Oculus helmets. We will emphasize the role of avatars and autonomous virtual humans in team playing. We will particularly discuss the recent developments in our volleyball game with avatars and autonomous players. In particular, we will explain key aspects like gaze interaction or picking ball.

Bio: Prof. Daniel Thalmann is a Swiss and Canadian Computer Scientist. He is currently Honorary Professor at EPFL, Switzerland, and Director of Research Development at MIRALab Sarl. Pioneer in research on Virtual Humans, his current research interests also include Virtual Reality, social robots, and crowd simulation.

Daniel Thalmann has been the Founder of The Virtual Reality Lab (VRlab) at EPFL, Switzerland, Professor at The University of Montreal and Visiting Professor/ Researcher at CERN, University of Nebraska, University of Tokyo, and National University of Singapore. From 2009 to 2018, he was Visiting Professor at the Institute for Media Innovation, Nanyang Technological University, Singapore.

He is co-editor-in-chief of the Journal of Computer Animation and Virtual Worlds, and member of the editorial board of 12 other journals. Daniel Thalmann was Program Chair and CoChair of several conferences including IEEE-VR, ACM-VRST, CASA, CGI, and ACM-VRCAI. Daniel Thalmann has published more than 600 papers in Graphics, Animation, and Virtual Reality. He is co-editor of 30 books, and coauthor of several books including 'Crowd Simulation' (second edition 2012) and 'Stepping Into Virtual Reality' (2007), published by Springer.

He received his Ph.D. in Computer Science in 1977 from the University of Geneva and an Honorary Doctorate from University Paul-Sabatier in Toulouse, France, in 2003. He also received the Eurographics Distinguished Career Award in 2010, the 2012 Canadian Human Computer Communications Society Achievement Award, and the CGI 2015 Career Achievement. More details on http://en.wikipedia.org/wiki/Daniel_Thalmann.
Prof. Dr. Franz-Erich Wolter  
Leibniz University of Hannover, Germany, fwolter@mit.edu

Title: Differential Geometric Instruments for Power Flow Computing and Beyond

Abstract: Rapidly growing technological “green energy” developments e.g. visible in traffic electrification has caused increased needs for scientific improvements on EE - power distribution systems with increasing flexibility regarding fast changes in EE-power loads. This resulted in calling for new more sophisticated methods for stability analysis and for finding optimal operation points for the respective power flow controlled by power grids. Central for understanding critical loads in a power grid is a critical set of points -partial to the solution set of the power flow equation- called solution space boundary “SSB”. Traditional computational methods of engineering analysis have been blind to delicate differential geometric features of the SSB such as principal curvatures and geodesic coordinates. Using the latter for analysis and parametrization of the SSB and its sub manifolds defined by technical forcing conditions provides major improvements for new more flexible tools for finding stable and more optimal solutions of the power flow equation thereby improving control of power grids. This seminar will focus on the static case of the power flow equation defined by a high–dimensional quadratic map requiring precise computations near its singularities including local inversion of the map. The latter singularities defining the SSB are root set of a high degree multivariate polynomial because they are zero set of the determinant of the Jacobean of the quadratic map. The SSB locally presents a regular hyper-surface at generic points. A local parametrization of the SSB hyper-surface is difficult to compute stably and accurately due to the high degree polynomials involved. Differential geometry methods using geodesic coordinates provide new ways to compute a local parametrization of the SSB, as well as of sub-manifolds of the SSB resulting from non-linear constraints. This numerical parametrization method for solutions of implicit equations systems is not restricted to the special equations at hand but applicable in more general settings.

A related paper can be found at: https://www.researchgate.net/publication/332093394

Bio: Professor Franz-Erich Wolter has been a professor of computer science at Leibniz University of Hannover (LUH) since 1994. Before coming to Hannover, Dr. Wolter held faculty positions at the University of Hamburg (in 1994), MIT (1989-1993) and Purdue University (1987-1989). He obtained his Ph.D. in 1985 from the Department of Mathematics at the Technical University of Berlin in the area of Riemannian geometry. In 1980 he graduated in mathematics and theoretical physics from the Free University of Berlin. At MIT, Dr. Wolter co-developed the geometric modeling system Praxiteles for the US Navy. The latter research and his prior theoretical Ph.D. research influenced his subsequent works in computational differential geometry where he is pursuing efforts in computing geodesic
joins, geodesic Voronoi diagrams, medial sets and singularities of the geodesic flow. Dr. Wolter’s research related to computer graphics and visualization includes diverse areas: Virtual Reality systems with an emphasis on haptic and tactile perception, biomedical visualization systems with haptic VR– interfaces and connected with medical multi-scale data analysis and biomechanical simulation in hearing mechanics and tactile perception. Most known are Dr. Wolter’s mathematical foundations of the “medial axis” and his pioneering works on using Riemannian spectral geometric concepts, like eigenvalues and heat kernel trace for cognition and analysis of surfaces, solids, and images. The latter includes his “Shape DNA” employing eigenvalues of the Riemannian Laplace Beltrami operator for shape cognition and analysis a method applied in a growing number of different fields such as Bio-medical imaging, (deep) manifold learning, 3d-search engines, quantum gravity, quantum shape effects, bio-molecular comparison, and remote sensing. Extending his prior works on using differential geometry for analyzing and visualizing singular behavior of non-linear dynamical systems - (modeling (bio)-physical systems and electrical circuits). Dr. Wolter most recently started applying computational differential geometry in EE-power flow computing.
Title: Digital Innovation for Surgery Simulation

Abstract: Surgical simulation has become a standard component of modern medical education. As a cost effective, risk-free and efficient way to expedite the early learning curve and augment surgical techniques, surgical simulation experienced over 2,500 years’ development since the very first recorded surgical simulator in India around 600 B.C. In recent decades, the innovation with the most tremendous potential for expanding the area of surgical simulation came with the advancing techniques from computer graphics, medical image processing, computer vision, data mining and artificial intelligence. Specifically, virtual reality (VR) and robotic simulators are increasingly used in surgical training programs, and substantial evidence demonstrates its significant validity. In this talk, I will present the evolution and application of computer graphics and vision techniques used in surgical simulation, including Soft Tissue Deformation, Object Detection & Tracking, Collision Detection, Haptic Force Feedback and Realistic Rendering etc. Current challenges and future tendency will also be discussed.

Bio: Dr. Yang is currently an Associate Professor at the National Centre for Computer Animation, Bournemouth University, United Kingdom. His research focuses on a number of topics relating to computer animation, motion capture and synthesis, computer vision, data mining, deep learning, digital health, virtual reality and surgery simulation. Dr. Yang received his Bachelor (1993) and Master degree (1996) in Computer Science from Zhejiang University (P. R. China), Ph.D.(2000) in Computing Mechanics from Dalian University of Technology (P. R. China), PostDoc (2000-2002) in Tsinghua University on Scientific Visualization, Research Assistant (2001-2002) at the "Virtual Reality, Visualization and Imaging Research Centre" of Chinese University of Hong Kong. He joined NCCA at 2003, continue his research on computer animation, and keep exploring the potential of cross-disciplinary application and impacts. He has produced more than 70 peer reviewed publications that include international journal articles, conference papers, and book chapters. His work on muscle modeling and deformation has aroused lots of attentions and has been widely reported by New Scientist, Wiedza I Zycie and MIT Technic Review etc. As PI and Co-I, he has secured over 17 research grants from European Commission, British Academy, Leverhulme, British Council, Newton Fund, InterReg VA France (Channel) England, Department for Business, Innovation & Skills (UK), Wessex Academic Health Science Network, Higher Education Innovation Fund, Royal Bournemouth Hospital NHS Foundation Trust, Royal National Lifeboat Institution, etc. He has been appointed as chair and examiner for PhD viva for
several times, including External PhD Examiner for The University of Edinburgh, Durham University, University of Sheffield, University of Bath, University of Calgary (Canada), University of Northumbria and University of Bedfordshire. Dr. Yang is a member of the Program Committee for several international conferences, reviewer for many peer review journals and conferences. He has given several invited talks and keynote presentations internationally.

Prof. Dr. Svetlana Yanushkevich
University of Calgary, Canada, syanshk@ucalgary.ca

Title: Smart environments: from Machine Learning to Machine Reasoning

Abstract: There are two different types of requirements to smart-city infrastructure: 1) service for citizens, educational centers, health care, public safety providers, governmental institutions, and 2) operational environments from the city administrations. These services should be intelligent, highly-integrated into social infrastructure, user-centric, and reachable everywhere. In this talk, we focus on city services such as emergency shelters. This talk addresses an urgent need for layered identity and security management in emergency shelters and similar facilities. The core of the proposed approach is advanced authentication (using machine learning) and risk assessment (using machine reasoning) technologies. We describe the e-interviewer, – a novel balancing mechanism between the security and privacy for both the shelter clients and personnel. A proof of concept is provided via 1) modeling using inference and deep learning techniques, and 2) the prototyping of e-interviewer components. The proposed inference engine operates using continuous authentication and risk assessment methodology via causal pathways. It utilizes multiple uncertainty metrics and links various risk factors. The e-interviewer is a platform that shall be built upon a more intensive use of probabilistic reasoning and learning techniques.

Bio: Dr. Svetlana N. Yanushkevich is a Professor at the Department of Electrical and Computer Engineering, University of Calgary. She received her Dr Tech Sciences (Dr Habilitated) from Warsaw University of Technology in 1999. She is directing the Biometric Technologies Laboratory (www.ucalgary.ca/btlab) and conducting research in the area of biometric-based authentication technologies.