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Organized by



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THE EUROPEAN ASSOCIATION
FOR COMPUTER GRAPHICS



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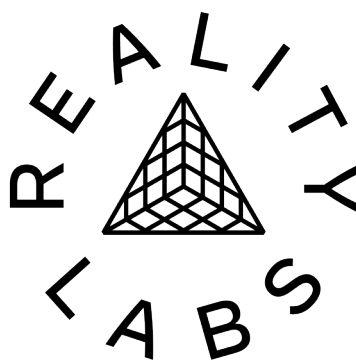
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Preface

This issue of the Computer Graphics Forum contains the technical full papers program of the Eurographics Association 45th annual conference, held in Limassol, Cyprus from April 22 to 26, 2024. The Eurographics annual venue presents a unique opportunity to present outstanding technical contributions in computer graphics. The full papers selected for publication in the Computer Graphics Forum journal are arguably the most prestigious feature of the conference.

The technical paper selection process involved a group of 86 experts forming the International Program Committee (IPC). We invited experts without more than three consecutive years of participation in the IPC so that the committee can be regularly renewed. The IPC members covered a diverse range of research subareas in computer graphics. They also covered all continents spanning Europe, Asia, North and South America, Africa, and Oceania.

We received a total of 161 valid submissions. A sorting committee, consisting of the two Chairs and seven advisory board members subsequently assigned each paper to two IPC members, as either primary or secondary reviewer, up to five papers, respecting their preferences, expertise, conflicts, and automatically computed matching scores between IPC members and submitted papers. The primary and secondary reviewers in turn invited three additional tertiary reviewers on each submission.

After the initial five reviews per submission were collected, the authors had a week to consult these reviews and write a 1000-word rebuttal, addressing key questions and potential misinterpretations. Finally, all reviewers assigned to a paper read the rebuttal and all reviews and together reached an initial decision.

This year, following an established tradition that started in 2012 and improved continuously through the years, we replaced the traditional in-person IPC meeting with a one-week virtual asynchronous meeting, where the discussions between the IPC members leading to the final decisions were performed off-line by a bulletin board and other means of personal communication. This led to extensive discussions where papers and reviews were debated extensively involving other IPC members as extra readers when needed. Each paper had a discussion board, and each and every IPC member contributed to discussions where they felt competent.

All papers conditionally accepted with minor revisions went through a short second review cycle, with evaluations from the primary reviewer, and sometimes the secondary reviewer, before being finally accepted.

In the end, *53 papers out of the 161 full submissions* were accepted with minor revisions, resulting in a *32.9% acceptance rate*. 9 more papers were recommended to a fast-track review process with major revisions to be considered for publication in a future issue of Computer Graphics Forum. This year we had papers on a diverse range of topics including generative AI, character animation, digital humans, face modeling, texture synthesis, geometry processing, meshes, fabrication, cloth simulation, fluid simulation, neural rendering, rendering and simulation of natural phenomena, reflectance models, perceptual rendering, image enhancement, sampling, denoising, vector art, line drawings, typography, motion tracking, procedural modeling, 3D reconstruction, shape analysis, scene understanding, and camera path generation.

All accepted full papers are published as open-access Computer Graphics Journal papers. It is worth noting that for all submissions conflict-of-interest was managed on all levels, from reviewers, committee, advisory board, best paper committee, up to the chairs. The review process for tertiary reviewers was double-blind and in case the original set of reviewers did not conclude with a decision, additional reviewers were invited to perform a full review and assist the decision process. Best papers were selected by a dedicated awards committee who selected among the top 10 papers based on overall review scores.

We would like to thank everyone who made this possible. First and foremost, we are grateful to all the members of the IPC who dedicated a remarkable amount of their time to finding tertiaries, reviewing papers, discussing papers during the virtual IPC meeting (1190 messages were posted on the discussion board during the post-rebuttal period!), and subsequently shepherding the accepted papers undergoing the minor revision cycle. We wish to thank all the reviewers, who provided 825 reviews in total and, of course, all the authors for their efforts in preparing and revising the submitted papers. We are especially grateful to *Michael Wimmer* who shared with us the insights from previous years and was indefatigable with his help and assistance. We would like to express strong appreciation to the advisory board for their support with paper sorting. Last but not least, we would like to thank *Stefanie Behnke* from Eurographics Publishing for her outstanding support with SRM functionality for her responsiveness which was the key to the successful outcome of the paper selection process.

We are very happy to present the full paper proceedings of Eurographics 2024. We believe that these papers reflect the extraordinary variety of computer graphics research and excellent contributions. It was both an honor and a pleasure for us to lead this selection process and we hope that you will find both the papers and the entire conference thought-provoking and inspiring of your future endeavors.

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Eurographics Distinguished Career Award 2024: George Drettakis



George Drettakis receives the EUROGRAPHICS Distinguished Career Award 2024. George is an INRIA Senior Researcher. He graduated from the University of Crete, and holds an M.Sc. and Ph.D. from the University of Toronto. He was a researcher in the iMAGIS group at INRIA Grenoble, and founded the REVES research group at INRIA Sophia-Antipolis. Since 2016 he has directed the follow-up group GRAPHDECO. George is a EUROGRAPHICS Fellow and received the EUROGRAPHICS Outstanding Technical Contributions Award in 2007.

Throughout his career he made significant contributions to all aspects of rendering, including image-based approaches, perception, cross-modality, weathering, relighting, or interactive techniques with a recent focus on deep learning methods. From earlier work on perspective shadow maps to more recent advances in neural ren-

dering, George is consistently pushing the envelope in novel and creative ways.

A hallmark of his research are the practical applications enabled by his proposed solutions, built on a solid theoretical background but always including a profound understanding of the actual stumbling blocks and problems that CG practitioners face. He was awarded an ERC Advanced Grant to research the benefits of accurate, approximate and image-based rendering techniques in a unified framework. His more recent works continue to receive significant attention, including the recent 3D Gaussian Splatting method for real-time radiance field rendering that has significantly impacted both research and industry.

In addition to being a distinguished researcher, George has served in multiple roles in the community. For example: he chairs the ACM SIGGRAPH Papers Advisory Group and the EUROGRAPHICS Steering Committee for the Working Group on Rendering; he was the SIGGRAPH Asia 2010 technical papers chair, and co-chaired both the EUROGRAPHICS Conference and the EUROGRAPHICS Workshop on Rendering. He has been co-editor in chief of top computer graphics journals. George has mentored many young researchers, graduating more than twenty Ph.D. students who built successful careers both in industry and academia.

EUROGRAPHICS is extremely pleased to honor George Drettakis with the 2024 Distinguished Career Award in recognition of his leadership and seminal contributions to one of the core areas in computer graphics.

Eurographics Outstanding Technical Contribution Award 2024: Anat Levin



breaking new possibilities in other areas of science and technology, beyond visual computing. For instance, her recent works at the intersection of optics and computational imaging have enabled entirely new ways of material measurement, for instance to image low SNR biological targets deep inside scattering tissue and correcting severe aberrations. These works also lay the foundations for new types of displays.

Anat Levin has published highly cited works in the top tier conferences and journals of computer graphics and computer vision. Due to the interdisciplinary nature of her research, her works are equally widely recognized in top tier publication venues of physics and optics.

EUROGRAPHICS is extremely pleased to recognize Anat Levin with the 2024 Outstanding Technical Contributions Award.

Anat Levin receives the EUROGRAPHICS Outstanding Technical Contributions Award 2024. Anat received her PhD in Computer Science from The Hebrew University of Jerusalem in 2006, and was a postdoctoral researcher at MIT. She was a professor at the Weizmann Institute of Science and is now a professor at the Technion. For her research, Anat received numerous honors, including two ERC Starting Grants and an ERC Consolidator Grant.

Anat Levin made groundbreaking contributions to computational photography and imaging, and has recently presented very innovative new ways to utilize principles from optics and computer graphics light transport simulation for real world physical measurements, in particular, for imaging deep inside scattering tissue. Her seminal works build essential mathematical foundations in these areas. The following are examples from her work.

Anat is well known for her work on colorization of grayscale images, matting, and deblurring. Her works in this domain are widely cited and considered seminal papers in the field. Further on, Anat has contributed groundbreaking works in the area of coded aperture imaging where she showed how unconventional optics and computational optimization enable the extraction of previously unattainable information from a single image.

More recently, she has continued to explore how concepts from computer graphics, and computational imaging open up ground-

Eurographics Young Researcher Award 2024: Justus Thies



Justus Thies receives the EUROGRAPHICS Young Researcher Award 2024. Justus obtained his PhD from the University of Erlangen Nuremberg. He is now a full Professor at the Technical University of Darmstadt where he is leading the 3D Graphics & Vision group. In addition, he is an independent research group leader at the Max Planck Institute for Intelligent Systems.

Justus studies the capture and synthesis of digital humans. His work blends elements of computer graphics, computer vision, and machine learning, with the end goal of capturing and re-synthesizing reality. Justus has done profound work on important aspects of “digital humans”, namely marker-less capture, neural synthesis, and multi-media forensics, among others.

Justus’ Face2Face algorithm was a pioneering and very successful approach to real-time facial performance capture from video data which also enabled facial re-enactment. Later, with the advent of neural networks, Justus again considerably advanced the state of the art with his work on deferred neural rendering. Importantly, new methods for high-quality image and video, colloquially known

as “deep fakes,” can also be abused, e.g. for misinformation. Justus and colleagues have made great strides on this equally important aspect in their work FaceForensics++, which allows to detect manipulated facial images. As the saying goes: “It takes (someone that makes) one to know one”, thus it is of paramount importance that researchers that develop new machine learning-based image synthesis approaches with all their great potential for computer graphics, additionally invest in identifying synthesized imagery. Justus’ groundbreaking work is a demonstration of this principle.

The work of Justus Thies is published in the top tier conferences and journals of computer graphics and computer vision, and has been very widely cited. His work also received several honors, such as the emerging technology award at SIGGRAPH 2016. With his considerable and impactful contributions to the field of digital humans, Justus helps to shape the future of how the real and the virtual interact.

EUROGRAPHICS is extremely pleased to recognize Justus Thies with the 2024 Young Researcher Award in recognition of his outstanding contributions to Computer Graphics in the area of marker-less motion capture and synthesis.

Eurographics Young Researcher Award 2024: Thomas Müller



Thomas Müller receives the EUROGRAPHICS Young Researcher Award 2024. Thomas received his PhD from ETH Zürich. He is now a Principal Research Scientist at Nvidia.

Thomas contributed very impactful research results at the intersection of machine learning and (inverse) light transport simulation. His works also had a great impact in practical applications.

Examples from his earlier work are new techniques to render polydisperse, heterogeneous and dynamic, granular mixtures by introducing a grain scattering distribution function. Further, his new approach on practical path guiding using learned spatio-directional radiance fields received the EGSR Best Paper Award. He also showed a new way to utilize deep networks for the prediction of the light transport inside of clouds in order to approximate atmospheric effects at low cost. Later, he presented seminal works on using neural networks for neural importance sampling in rendering, as well as on rendering of complex participating media effects.

In recent years, one of his major areas of research became inverse rendering techniques and neural reconstruction methods. Variable

Bitrate Neural Fields and, especially, Instant Neural Graphics primitives, had a significant impact and enabled a new level of performance in capturing neural fields. The latter received the SIGGRAPH Best Paper Award, as well as the TIME Best Inventions of 2022 Award. Such techniques made projects like Neuralangelo possible, in which a high-fidelity surface reconstruction of the David statue by Michelangelo was presented.

Thomas also contributed to the community in the form of several noteworthy and widely used libraries, such as *tiny-cuda-nn* or the image comparison tool *tev*. His works were published in the top tier journals and conferences of computer graphics and computer vision. The various honors and awards he already received further illustrate the strong impact that Thomas had on the field of Computer Graphics and Computer Vision.

EUROGRAPHICS is extremely pleased to recognize Thomas Müller with the 2024 Young Researcher Award in recognition of his outstanding contributions to Computer Graphics in the area of machine learning and (inverse) light transport simulation.

Bringing Digital Characters and Avatars to Life

Markus Gross



unit, where he and his team are pushing the forefront of technology innovation in service of the filmmaking process. Gross has published over 500 scientific papers and holds over 100 patents. His work and achievements have been recognized widely, including two Academy Awards and the ACM SIGGRAPH Steven Anson Coons Award. Gross is member of multiple academies of science and of the Academy of Motion Picture Arts and Sciences.

Abstract

The creation of lifelike digital human faces has been pivotal in a range of applications, spanning from healthcare and telepresence to virtual assistants and cinematic visual effects. For decades, the ultimate objective has been to create digital representations so authentic that they are virtually indistinguishable from real faces, while also conveying genuine emotional depth. Overcoming the challenge of the “uncanny valley” has been crucial to this pursuit. In this talk, I will give a 30-year retrospective of pioneering research in digital humans. We will explore the evolution of various elements—including facial capture techniques, geometry, appearance modeling, soft tissue modeling as well as eyes, teeth, and hair.

The talk will also highlight the transformative impact of contemporary machine learning on facial visual effects. As we look toward the future, the focus will shift to real-time facial animation and the symbiotic relationship between digital characters and machine learning algorithms to bring AI avatars to life.

Biography

Markus Gross is the Chief Scientist of the Walt Disney Studios and a professor of Computer Science at ETH Zürich. He is one of the leading authorities in visual computing, computer animation, digital humans, virtual reality, and machine learning. In his role at Disney he leads the Studio segment’s research and innovation

Image-Based Rendering: From View Synthesis to Neural Radiance Fields and Beyond

Ravi Ramamoorthi



Abstract

Applications in augmented reality, 3D photography, immersive experiences and appearance acquisition require solving the view synthesis problem – given a few images of an object or scene of interest, how can we synthesize images from new viewpoints. This is a fundamental problem in computer vision and graphics, often referred to as image-based rendering, and can be encapsulated as reconstructing the light field of all light passing through a scene from a set of observations. In this talk, I will first briefly describe the 30-year history of the problem and seminal papers, then discuss a series of efforts my group has made in light field synthesis from sparse images, ultimately leading to the now widely used neural radiance field representation. I discuss the impact of this work and follow-ups, leading to newer work from my group on personalized avatars, enabling real-time radiance fields or live 3D portraits from a single image.

Biography

Ravi Ramamoorthi is the Ronald L. Graham Professor of Computer Science at UCSD and founding director of the UC San Diego Center for Visual Computing. He earlier held tenured faculty positions at UC Berkeley and Columbia University, in all of which he played a key leadership role in building multi-faculty research groups recognized as leaders in computer vision and graphics. He

has authored more than 200 refereed publications in computer graphics and vision, including 90+ ACM SIGGRAPH/TOG papers. Prof. Ramamoorthi has introduced widely used theoretical representations and computational models for problems in vision and graphics, such as spherical harmonic lighting and neural radiance fields, and widely adopted methods in industry such as Monte Carlo denoising. He has consulted with Pixar and startups in computational imaging, and currently holds a part-time appointment as a Distinguished Research Scientist at NVIDIA. Prof. Ramamoorthi has received about twenty major honors for his research including the ACM SIGGRAPH Significant New Researcher Award for his work in computer graphics, and the Presidential Early Career Award for Scientists and Engineers for his work on physics-based computer vision. He is a fellow of IEEE, ACM and the SIGGRAPH Academy, recently received an inaugural Frontiers of Science Award, and has twice been honored with the edX Prize certificate for exceptional contributions in online teaching and learning. He has graduated more than 30 postdoctoral and Ph.D. students, whose theses have been recognized by the ACM Dissertation Award honorable mention, the ACM SIGGRAPH outstanding dissertation award and the UCSD Chancellor's Dissertation Medal.

From *Single-Video* Models to *All-Video* Models

Tali Dekel



toral Associate at the Computer Science and Artificial Intelligence Lab (CSAIL) at MIT. Tali completed her Ph.D. studies at the school of electrical engineering, Tel-Aviv University, Israel. Her research interests include computational photography, image/video synthesis, geometry, and 3D reconstruction. Her awards and honors include the National Postdoctoral Award for Advancing Women in Science (2014), the Rothschild Postdoctoral Fellowship (2015), the SAMSON – Prime Minister’s Researcher Recruitment Prize (2019), Best Paper Honorable Mention in CVPR 2019, and Best Paper Award (Marr Prize) in ICCV 2019. She often serves as program committee member and area chair of major vision and graphics conferences More information in: <https://www.weizmann.ac.il/math/dekel/home>

Abstract

The field of computer vision is in the midst of a generative revolution, demonstrating groundbreaking image synthesis results, portraying highly complex visual concepts such as objects’ interaction, lighting, 3D shape, and pose. Expanding this progress to videos introduces two key challenges: (i) the distribution of natural videos is vast and complex, requiring orders of magnitude more training data than images, and (ii) raw video data is extremely high dimensional, requiring extensive computation and memory. In this talk, I’ll present different methodologies aimed at overcoming these challenges and advancing our capabilities to synthesize and edit visual content across both space and time. These methods range from layered video representations tailored to a specific video, to leveraging generative image priors for video synthesis tasks, and finally, designing and harnessing large-scale text-to-video models, which provides us with powerful motion priors. I’ll demonstrate how these methods unlock a variety of novel content creation applications, such as transferring motion across distinct object categories, image-to-video synthesis, video inpainting, and stylized video generation.

Biography

Tali Dekel is an Assistant Professor at the Mathematics and Computer Science Department at the Weizmann Institute, Israel. She is also a Staff Research Scientist at Google, developing algorithms at the intersection of computer vision, computer graphics, and machine learning. Before Google, she was a Postdoc-

Compositional Modeling of 3D Objects and Scenes

Leonidas Guibas



Stanford University under the supervision of Donald Knuth. His main subsequent employers were Xerox PARC, DEC/SRC, MIT, and Stanford, including stays at Meta, Google, and Autodesk. He has worked in numerous areas of computer science, such as geometric algorithms, computer vision, computer graphics, robotics, machine learning, discrete mathematics, and biocomputation. At Stanford he is a member and past acting director of the Artificial Intelligence Laboratory and a member of the Computer Graphics Laboratory, the Institute for Computational and Mathematical Engineering (iCME), and the Bio-X program. Dr. Guibas has been elected to the US National Academy of Engineering, the US National Academy of Sciences, and the American Academy of Arts and Sciences and is an ACM Fellow, an IEEE Fellow, and winner of the ACM Allen Newell Award, the ICCV Helmholtz prize, and Siggraph's Test-of-Time paper award.

Abstract

The compositional structure of objects (into parts) and of scenes (into objects) is central to many tasks in 3D scene understanding or 3D content creation. The identification and organization of structural components and their metric and relational attributes informs the modeling of component geometry, arrangements, affordances, and functionality – while also providing tools for semantics-aware content selection and manipulation. This talk will highlight some of the history and progress on neural approaches enabling representations for 3D objects and scenes that are, or can be made to be, structure aware – along with the challenges associated with obtaining data sets, data annotations, etc. It will also demonstrate how, in turn, such structural information allows improved or more efficient 3D reconstruction or generation, as well as the controllable creation of variations, both discrete and continuous. Finally, the talk examines how 3D compositional structure can emerge from data without little or no human supervision, how it is reflected in natural language, and how we can increase 3D structure awareness and spatial reasoning abilities in current large-scale LLMs and VLMs.

Biography

Leonidas Guibas is the Paul Pigott Professor of Computer Science (and by courtesy), Electrical Engineering at Stanford University, where he heads the Geometric Computation group, and also a Principal Scientist at Google. Prof. Guibas obtained his Ph.D. from