1 Gabriel Zachmann

Curriculum Vitae

Personal Data

Title	Prof. Dr.-Ing.
First name	Gabriel
Name	Zachmann
Current position	W3 Professor of Computer Graphics and Virtual Reality
Current institution(s)/ site(s), country	University of Bremen, DE
Identifiers/ORCID	ORCID-ID: 0000-0001-8155-1127; Google Scholar: https://scholar.google.com/citations?user=rB_y-IkAAAAJ

Qualifications and Career

After obtaining my intermediate diploma at Karlsruhe University, I moved to the University of Darmstadt as I had developed a passion for computer graphics. The Fraunhofer Institute for Computer Graphics (IGD), led by the university's computer graphics pioneer Jose Encarnação offered the most opportunities in Germany at the time. Soon, I got the chance to join the IGD as a student research assistant in the department for virtual reality (VR). As a young researcher at IGD, I witnessed and took part in the first wave of VR, which has been formative for my whole career. While being a student in Darmstadt, I attended courses in related mathematical fields, most notably computer-aided geometric design and differential and integral geometry, taught by renowned Josef Hoschek. This combination of formal training in mathematics with computer graphics and virtual reality influenced me substantially, and I pursued the subject in my PhD thesis and beyond. It enabled me to develop a number of efficient and rigorous methods in geometric computing, which subsequently facilitated me to acquire over 6 million Euros of funding over the past 20 years (counting only the parts that were awarded to me) including a prestigious DFG-funded Emmy-Noether Junior Investigator's Group early on in my career. Also, these methods are enabling ones for physics engines, which are now part of every game engine, and which are being used as the main platform for virtually all VR systems. However, many research challenges remain, such as efficient geometric computing methods for dynamic point clouds and deformable objects consisting of millions of polygons, or the problem of generating 3D models automatically. In the context of this GRK, providing remote presence of expert surgeons during live OPs by live point cloud avatars and intuitive 3D interaction techniques presents interesting scientific challenges for efficient geometric computations (e.g., point cloud rendering in VR). Also, automatically generating VR scenarios for training emergency situations presents very ambitious scientific problems.

Stages	**Periods and Details**
Degree program	Diploma, Computer science, 1988–1994, Karlsruhe University of Technology (now KIT) and Technical University of Darmstadt, DE

Doctorate	2000, Dr.-Ing., with distinction, J. Encarnação/ C. Cruz-Neira, “Virtual Reality Assembly Simulation - Collision Detection, Simulation Algorithms, and Interaction Techniques”, Technical University of Darmstadt, DE
Stages of academic/ professional career	● Since 2012: W3 professor, Computer Graphics and Virtual Reality, University Bremen, DE ● 2010: visiting professor, Nanyang Technological University, SG ● 2005–2012: W2 professor, Computer Graphics, Clausthal University, DE ● 2003–2005: Head of the DFG-funded Emmy-Noether Junior Investigator's Group, "New, Intuitive Interaction Methods for Efficient, Next Generation Virtual Prototyping", University of Bonn, DE ● 2001–2003: Postdoc, Computer Graphics Group, University of Bonn, DE ● 1994–2001: Researcher, VR & Visualization Department, Fraunhofer IGD, Darmstadt, DE ● 1994: Research stay, National Center for Supercomputing Applications (NCSA), Urbana/Champaign, Illinois, US

Engagement in the Research System

I am point of liaison for the university’s strategic partnership with Mahidol University in Bangkok, Thailand. The partnership involves vivid exchanges of staff, students, and ideas. In addition, I am a member of the board of the Center for Computing and Communication Technologies (TZI) and the Bremen Spatial Cognition Center (BSCC), through which I can contribute to the transfer of knowledge of ARISE into industry.

To create a strong and vibrant scientific community in VR/AR/XR, I co-founded the European Association for Extended Reality (EuroXR) in 2009, and I have been on its board since then. Just recently, I have been appointed its Vice President of Academic Affairs. To put Bremen on the map with respect to VR and XR, I have helped organize a number of conferences here, (e.g., the Joint Virtual Reality Conference, or the GI workshop on VRAR) and elsewhere (e.g., IEEE VR, ACM Web3D). My activities at XR conferences will facilitate the visibility of this GRK to a community beyond the fields of virtual reality and computer graphics. Of course, I have served on the IPCs of all the major conferences and journals in my area (IEEE VR, ACM Siggraph, Eurographics, ACM VRST, IEEE Transactions on Visualization and Computer Graphics, ACM Haptic Symposium, to name just a few), thereby keeping me and my doctoral students at the cutting edge of research.

Since 2021, I am serving as an Associate Editor for the Springer journal “The Visual Computer“ (editor-in-chief: Nadia Magnenat-Thalmann). From 2013-2018, I acted as an external examiner and advisor to the study program “Interactive Entertainment Technology” for Trinity College Dublin, Ireland. For various funding agencies, I have been a reviewer of a large number of research proposals, including the DFG, the European Human Brain Project, the Cyprus Research Promotion Foundation (RPF), the Austrian Science Foundation (FFG), to name but a few.

Supervision of Researchers in Early Career Phases

Over the past 10 years, I have led 22 doctoral students towards their dissertation (9 of them as first supervisor, see list below). Two of my doctoral students graduated with distinction, and Rene Weller won the best PhD dissertation prize of the EuroHaptics Association.

In general, I try to empower doctoral students in several ways, so that they can later take on leading roles in industry and academia. for instance, they get to teach bachelor's and master's students in the tutorials that accompany my lectures; occasionally, they also substitute me during a lecture. Also, they regularly advise bachelor's and master's theses. In funded projects (BMBF or DFG), they manage most of the administrative tasks themselves, such as organizing meetings and milestone presentations with all the partners.

Several of my former students hold prestigious researcher positions: Patrick Lange is now a head of department at the German Research Center for Artificial Intelligence (DFKI). Xizhi Li is a researcher at the renowned Shanghai Astronomical Observatory, Chinese Academy of Sciences. David Mainzer is a Senior Software Engineer at Bosch GmbH, a world-leading technology provider for car industries. During the course of my career, I supervised over 200 master's, bachelor's, and diploma students. I am also shaping the careers of students on a structural level: for instance, at Clausthal University I served as the dean of studies in computer science; for University of Bremen, I am serving on the steering board of the study program Digital Media.

Nr	Name	Title	Year
1	Muiris Woulfe	A Hybrid Software and Hardware System for Collision Detection	2009
2	Markus Schlattmann	Real-Time Markerless Tracking the Human Hands for 3D Interaction	2011
3	Rene Weller	New Geometric Data Structures for Collision Detection	2012
4	Daniel Mohr	Model-Based High-Dimensional Pose Estimation with Application to Hand Tracking	2012
5	Matthias Moehring	Realistic Interaction with Virtual Objects Within Arm's Reach	2012
6	Adrien Girard	Interactions visio-haptiques pour la coordination et la conscience situationnelle partagée en environnement virtuel collaboratif	2014
7	Stefan Mock	Simulation von hoch polydispersen zufällig dichten Partikelpackungen unter Berücksichtigung der Agglomeration im Feinstkornbereich	2015
8	David Mainzer	New Geometric Algorithms and Data Structures for Collision Detection of Dynamically Deforming Objects	2015
9	Alexander Kuenz	High Performance Conflict Detection and Resolution for Multi-Dimensional Objects	2015
10	Roman Vlasov	Exploration of Medical Data Using Haptic Rendering	2016
11	Patrick Lange	New Concepts for Virtual Testbeds, Data Mining Algorithms for Blackbox Optimization based on Wait-Free Concurrency and Generative Simulation	2018
12	Andreas Tarnowsky	Modelle zur Synthese taktiler Reize	2018

13	Mikel Sagardia	Virtual Manipulations with Force Feedback in Complex Interaction Scenarios	2019
14	Xizhi Li	Procedural 3D Asteroid Model Synthesis	2020
15	Steve Grogorick	Guiding Visual Attention in Immersive Environments	2020
16	Michael Otto	The Virtual Manufacturing Station, A Framework for Collaborative Assessment of Manual Assembly Tasks	2020
17	Moritz Cohrs	New Methodologies for Automotive PLM by Integrating 3D CAD and Virtual Reality into Function-oriented Development	2021
18	Matthias Noeker	Surface Gravity Modeling and Space Gravimeter Development in the Context of Solar System Small Bodies	2022
19	Roland Fischer	Novel Algorithms and Methods for Immersive Telepresence and Collaborative VR	2023
20	Toni Tan	Geometric Computing for Simulation-Based Robot Planning	2023
21	Max Kaluschke	Immersive Medical VR Training Simulators with Haptic Feedback	2024
22	Max von Buelow	Visual Insights into Memory Behavior of GPU Ray Tracers	2024

Scientific Results

Category A

My research and publications have made an impact in a diverse set of fields, both in my core research areas as well as neighbouring disciplines. This shows that the methods I am working on are of great value in many areas, such as computer graphics, virtual reality, robotics, human-computer interaction, and simulation.

With our work on sphere packings, we have introduced a whole new object representation into the field of computer graphics and provided methods and algorithms to create and work with them extremely efficiently. Also, we have applied them to novel medical VR simulators.

1. Debowski N, Weller R, **Zachmann G** (2017) kDet - Parallel Constant Time Collision Detection for Polygonal Objects. Computer graphics forum, April 2017 (Eurographics conf.)
   This is a fundamental methodology for physically-based simulation, which will play an important role in the virtual twins planned within the GRK's research.
2. Kaluschke M, Weller R, Yin M S, Hosp B W, Kulapichitr F, Haddawy P, Suebnukarn S, **Zachmann G** (2024): Reflecting on Excellence: VR Simulation for Learning Indirect Vision in Complex Bi-Manual Tasks. IEEE Conference on Virtual Reality and 3D User Interfaces (VR), March 2024.
   We discovered eye gaze patterns that can predict learning progress among medical students.

3. Weller R, **Zachmann G** (2010) ProtoSphere: A GPU-Assisted Prototype-Guided Sphere Packing Algorithm for Arbitrary Objects. ACM SIGGRAPH ASIA 2010 Sketches.
   This methodology can be used for researching medical VR simulations.
4. Schröder C, Al Zaidawi SM, Prinzler M, Maneth S, **Zachmann G** (2020) Robustness of Eye Movement Biometrics Against Varying Stimuli and Varying Trajectory Length. ACM CHI Conference 2020.
   Understanding the mental state and foreseeing human actions will be important for this GRK; to this end, extracting information from human eye movements can be very helpful.
5. Tan T, Weller R, **Zachmann G** (2019) SIMDop: SIMD Optimized Bounding Volume Hierarchies for Collision Detection. Proc. of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS).
   This work will help with the medical VR simulations, similar to reference #3.
6. Rosskamp J, Weller R, and **Zachmann G** (2024) Effects of Markers in Training Datasets on the Accuracy of 6D Pose Estimation. Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision (WACV), 2024, 4457-4466.

Category B

1. Langetepe E, **Zachmann G**: Geometric Data Structures for Computer Graphics. AK Peters / Tayler & Francis, 2006
   This book was a successor to several very successful tutorials we gave at the prestigious ACM Siggraph and Eurographics conferences several times (over 400 participants at Siggraph).

2. *We have published a software suite, CollDet, for performing extremely fast collision detection and proximity computations (less than 1 msec for millions of polygons). In addition, we published a suite of benchmarking models, as well as a Benchmark-as-a-Service for the research community and industries. See:* Tan T, Weller R, **Zachmann G** (2022) A Framework for Safe Execution of User-Uploaded Algorithms, ACM Web3D 2022. And: Weller R, Mainzer D, **Zachmann G**, Sagardia M, Hulin T, Preusche C (2010) A Benchmarking Suite for 6-DOF Real Time Collision Response Algorithms, ACM Symp. on Virtual Reality Software and Technology 2010 (VRST' 2010)

3. Mohr D, **Zachmann G** (2013) Hand pose recognition – overview and current research. In Brunnett G, Coquillart S, van Liere R, Welch G, Váša L (eds.), Virtual Realities, pp. 108-129. Springer (Dagstuhl Seminar), 2013. *Recognition of human activities will be an important capability of robots for co-construction between robots and humans.*

Academic Distinctions

In total, I have received 8 best papers awards. We received these at prestigious conferences such as ACM SIGSIM PADS, IEEE Haptics Symposium, or EuroXR.

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