

Hosting offer for Marie Skłodowska-Curie Postdoctoral Fellowships (PF) 2022 at University of Bremen's Visual Computing Research Group (CGVR)

[MSCA Postdoctoral Fellowships](#) are individual research grants offering excellent postdoctoral researchers the chance to develop their skills by means of international mobility. Through the implementation of an original and personalised research project, MSCA Postdoctoral Fellowships aim to foster excellence through training and mobility and to equip researchers with new skills and competences in order to identify solutions to current and future challenges.

The Visual Computing research group (CGVR) at the University of Bremen invites motivated postdoctoral researchers to jointly prepare an application for the [Marie Skłodowska-Curie Postdoctoral Fellowships](#) call ([MSCA-PF-2022](#)) with them as host organisation.

Description of Hosting organisation/group

The visual computing group has performed research in computer graphics, virtual reality, and computer vision for over 20 years. More specifically, we have extensive experience in geometric computing, in particular collision detection, proximity calculations, and force-feedback computations. Applications range from virtual prototyping, digital twins, medical virtual simulators, and simulation and visualization of space mission in VR.

Among many firsts, Zachmann et al. presented the first efficient methods to compute both intersection and proximity between a pair of arbitrary meshes. We also presented a very fast massively parallel method to compute such sphere packings, which is, to our knowledge, still the fastest world-wide. Recently, we have proposed a method for which we proved constant parallel running time for a wide class of polygonal meshes. We also defined, to the best of our knowledge, for the first time a geometric predicate that can be tested on single objects (instead of pairs of objects) asserting collision detection in constant parallel time. Recently, we have developed algorithms that can generate BVH's with any out-degree, and we have developed algorithms that utilize the SIMD capabilities of today's CPU architecture (SSE, AVX, etc.) while traversing those BVHs.

We have also done extensive previous work on medical virtual simulators. Together with partners, we developed a simulator for orthopedic surgeries, which requires force feedback inside a large working volume, very hard contacts (bones), very high forces, and material abrasion with varying bone hardness. Other simulators include optimization algorithms for autonomous surgical lamps, and a virtual anatomy atlas. Ongoing research investigates intra-operative virtual telepresence and novel lighting optimization in the OR.

Finally, Zachmann has performed research on virtual testbeds (VTB) in the context of space mission design, that allows for intuitive, virtual interaction with ROS-based third-party software-in-the-loop. We have also done research on improving communication and data exchange in virtual testbeds that use the entity-component-systems architecture.

We have participated and initiated a large number of research projects funded by various German funding bodies (DFG, BMBF, DLR, DAAD), industries (e.g., Volkswagen, BMW, Dr. Mach) and SME's (e.g., Szenaris, Haption).

The infrastructure available in our CGVR lab consists of a 4x2m dual-user stereo projection screen with optical tracking, a number of force-feedback devices (Virtuose 6D by Haption, one KUKA light-weight robot arm, two Phantoms, two Falcons), a lot of HMDs (Oculus, several generations of HTC Vive, XTAL, Varjo), several Azure Kinect's, and a large number of VR-ready PCs.

Web page: <https://cgvr.cs.uni-bremen.de>

Select publications:

Weller R, Zachmann G. ProtoSphere: A GPU-Assisted Prototype-Guided Sphere Packing Algorithm for Arbitrary Objects. ACM SIGGRAPH ASIA 2010 Sketches. 2010.

Weller R, Debowski N, Zachmann G. kDet: Parallel Constant Time Collision Detection for Polygonal Objects. Vol. 36, Computer Graphics Forum. 2017.

Tan T, Weller R, Zachmann G. SIMDop: SIMD optimized Bounding Volume Hierarchies for Collision Detection. 2019 IEEE/RSJ Int'l Conf. on Intelligent Robots and Systems (IROS). 2019

Weller R, Zachmann G. User Performance in complex bi-manual haptic manipulation with 3 DOFs vs. 6 DOFs. 2012 IEEE Haptics Symposium (HAPTICS).

Kaluschke M, Weller R, Zachmann G. A volumetric penetration measure for 6-DOF haptic rendering of streaming point clouds. 2017 IEEE World Haptics Conference (WHC). 2017.

Li, Vincent, Weller, Zachmann: Numerical approach to synthesizing realistic asteroid surfaces from morphological parameters. Astronomy & Astrophysics (A&A), March 2022.

Weller R, Zachmann G. A unified approach for physically-based simulations and haptic rendering. In: Proceedings of the 2009 ACM SIGGRAPH Symposium on Video Games. 2009.

Kaluschke M, Weller R, Zachmann G, Hammer N, Pelliccia L, Lorenz M: Realistic Haptic Feedback for Material Removal in Medical Simulations. ACM Haptic Symposium 2020.

Weyhe D, Uslar V, Weyhe F, Kaluschke M, Zachmann G. Immersive Anatomy Atlas—Empirical Study Investigating the Usability of a Virtual Reality Environment as a Learning Tool for Anatomy. Vol. 5, Frontiers in Surgery. 2018.

Teuber J, Weller R, Buinhas L, Kuhn D, Dittmann P, Srinivas A, et al. VaMEx-VTB A Modular Virtual Testbed for Multimodal Autonomous Planetary Missions. In: Proc of the 70th International Astronautical Congress (IAC).

Lange P, Weller R, Zachmann G. Knowledge Discovery for Pareto Based Multiobjective Optimization in Simulation. Proc. 2016 ACM Conf. on SIGSIM Principles of Advanced Discrete Simulation - SIGSIM-PADS '16. 2016

Zachmann, G: Adaptive Bitonic Sorting. Encyclopedia of Parallel Computing, Springer, 2011, pages 146-157; Padua, David (ed.)

Topics/expertise

We welcome all applications to work on an inspiring, novel research idea that will fit into one of our research areas, *or* that can bring fresh and novel aspects to one of our projects (no matter whether it is for ongoing or past projects). So, in short, your topic should somehow connect with us. We are highly flexible, and interested in novel ideas. If your past research is in an area like geometric computing, virtual reality, force feedback, robotics, medical simulation, to name but a few, then chances are high we can create a cool idea suitable for an MSCA fellowship proposal. In the following, you can find a few more specific topics that we find attractive, but, of course, we are open for many other ideas.

- Interaction metaphors in VR (we have some experience in redirected walking, and 3D selection);
- Geometric computing, in particular proximity computations with uncertainty built into the acceleration data structures (we have considerable experience in BVH's and other acceleration data structures);
- Physically-based simulation with uncertainty, or simulation strategies that allow for simulation of multiple trajectories at once;

- Sphere packings (non-uniform, arbitrary containers): all kinds of topics around that theme, such as using sphere packings for rendering, for force feedback, for sound simulation, generation of different kinds of sphere packings, etc. (we have several softwares for creating such sphere packings, and we have done a number of applications using them);
- Medical virtual simulators, and using VR/AR in the operating room (we have done several application-oriented projects in that area);
- Force feedback: all kinds of research questions around that theme, in particular simulation of hard contacts where very high forces occur; novel methodologies for rendering such forces (we have experience with rendering forces on a KUKA robot arm);
- Simulation in robotics, in particular research questions related to our expertise (geometric computing, rendering, virtual reality);
- Affordance discovery for robotics, in particular automatic AD using naïve simulation methods, or using neural networks;
- Natural, physically-plausible grasping in VR, e.g., using non-linear optimization methods (our penetration and distance computation software could be useful).

As stated above, many other research questions can be researched during the fellowship. Ideally, a good research topic would combine your expertise with ours.

Your profile

- Expected qualifications/expertise of the candidate: Candidates should have a PhD and an excellent Master's degree in computer science, or physics, mathematics, computational engineering, or other related areas. Required skills are solid experience in programming and software development, and a very good command of English (reading/writing/speaking). It would be a bonus, if you specialized in real-time computer graphics or physically-based simulation, you are capable of effectively applying mathematical methods, and you have good knowledge in GPGPU programming. Depending on the research topic, knowledge in machine learning and neural networks could be helpful. In addition, the successful candidate will be highly self-motivated, passionate about their work, and have good ability to work both independently as well as in a team in a multidisciplinary environment.
- You must have a completed PhD at the time of the call deadline (14 September 2022).
- Candidates must have a maximum of 8 years full-time research experience from the PhD award date until September 14, 2022. Periods of inactivity in research (e.g. unemployment, periods of employment outside research, parental or sick leave) do not count towards the time of research experience.
- For European fellowships, candidates can be of any nationality and must not have resided or carried out their main activity (work, studies, etc.) in Germany for more than 12 months in the 36 months immediately before September 14, 2022.
- Highly motivated candidate with an excellent research track record appropriate to career stage, as evidenced by academic publications and other scientific output.

What we offer

- Support and guidance for the preparation of your MSCA PF proposal, backed by the expertise of the Funding Advisory Service at the University of Bremen
- A stimulating, interdisciplinary environment for high-level research.
- Great opportunities for collaboration with other members both with the computer graphics group and other groups, e.g., robotics, computer vision, medical visualization.

- Dynamic, friendly, and helpful team of computer graphics researchers.
- Mid-sized university with about 20,000 students, a lot of them from abroad, offering a broad range of fringe benefits such as sports facilities, cultural activities, and daycare.

How to apply?

Indicate your interest by contacting the host institution as follows:

Please contact Prof. Dr. Gabriel Zachmann by email (zach at cs.uni-bremen.de) with a short CV and motivation letter to indicate your interest to prepare a MSCA-PF application.

After the supervisor agrees to support you as a MSCA-PF candidate, you can start preparation of MSCA PF project proposal and will be supported further by the Funding Advisory Service of the host university.

For more information please contact the MSCA coordinator of the host institution: eu@vw.uni-bremen.de