Dr. Patrick Diehl

Curriculum Vitæ

Education

2017 **PhD**, *Applied mathematics*, University of Bonn, Germany.

2012 **Diploma**, *Computer Science*, University of Stuttgart, Germany.

Research experience

10/18–current **Research scientist**, *Center for Computation & Technology*, Louisiana State University.

02/17–09/18 **Postdoctoral fellow**, *Laboratory of Multiscale Mechanics*, Polytechnique Montréal.

- Benchmark peridynamic simulations against experimental data for composite materials
- Extracting constitutive mechanical parameters in linear elasticity using the virtual fields method within the ordinary state-based peridynamic framework (with Rolland Delorme)
- Hybrid image processing approach for crack area detection and tracking using local Digital Image Correlation results (with Ilyass Tabiai)

04/13–01/17 **Research Assistant**, *Institute for Numerical Simulation*, University Bonn.

- Modeling and simulation of crack and fractures in solids using peridynamic

07/12–03/13 **Research Assistant**, *Institute for Simulation of large Systems*, University Stuttgart.

Visiting positions

2015 **Guest Research Assistant**, *Center for Computation and Technology*, Louisiana State University.

Certificates

Baden–Württemberg Certificate — Certificate for successful completion of the program in higher education pedagogy by the center for educational development of the state of Baden–Württemberg.

Research Interests

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Computational engineering
- Peridynamics theory for the application in solids, like glassy or composite materials,
- Validation and verification of simulations against experimental data,
- Assembly of experimental data for comparison with simulations,
- Application of machine learning to experiments and simulations.

High Performance Computing
- The C++ Standard Library for Parallelism and Concurrency (HPX),
- Asynchronous many task systems and there application in computational engineering.

Open science
- Open Source Software for scientific applications,
- Open data for sharing raw experimental results.

Publications

Journal articles

Michael Bußler, Patrick Diehl, Dirk Pflüger, Steffen Frey, Filip Sadlo, Thomas Ertl, and Marc Alexander Schweitzer. Visualization of Fracture Progression in Peridynamics. *Computer & Graphics*, 67:45–57, 2017.

Patrick Diehl, Fabian Franzelin, Dirk Pflüger, and Georg C. Ganzenmüller. Bond-based peridynamics: a quantitative study of Mode I crack opening. *International Journal of Fracture*, 2(201):157–170, 2016.

Patrick Diehl, Ilyass Tabiai, Felix W. Baumann, Daniel Therriault, and Martin Levesque. Long term availability of raw experimental data in experimental fracture mechanics. *Engineering Fracture Mechanics*, 197:21–26, 2018.

Proceedings

P. Diehl and M. A. Schweitzer. Efficient neighbor search for particle methods on GPUs. In M. Griebel and M. A. Schweitzer, editors, *Meshfree Methods for Partial Differential Equations VII*, volume 100 of *Lecture Notes in Computational Science and Engineering*, pages 81–95. Springer, 2014.

P. Diehl and M. A. Schweitzer. Simulation of wave propagation and impact damage in brittle materials using peridynamics. In Miriam Mehl, Manfred Bischoff, and Michael Schäfer, editors, *Recent Trends in Computational Engineering – CE2014*, volume 105 of *Lecture Notes in Computational Science and Engineering*, pages 251–265. Springer, 2015.

Patrick Diehl, Michael Bußler, Dirk Pflüger, Steffen Frey, Thomas Ertl, Filip Sadlo, and Marc Alexander Schweitzer. *Extraction of Fragments and Waves After Impact Damage in Particle-Based Simulations*, pages 17–34. Springer International Publishing, Cham, 2017.

F. Franzelin, P. Diehl, and D. Pflüger. Non-intrusive uncertainty quantification with sparse grids for multivariate peridynamic simulations. In M. Griebel and M. A. Schweitzer, editors, *Meshfree Methods for Partial Differential Equations VII*, volume

100 of *Lecture Notes in Computational Science and Engineering*, pages 115–143. Springer International Publishing, 2014.

Thomas Heller, Patrick Diehl, Zachary Byerly, John Biddiscombe, and Hartmut Kaiser. HPX – An open source C++ Standard Library for Parallelism and Concurrency. In *Proceedings of OpenSuCo 2017, Denver, Colorado USA, November 2017 (OpenSuCo 17)*, page 5, 2017.

Thomas Heller, Hartmut Kaiser, Patrick Diehl, Dietmar Fey, and Marc Alexander Schweitzer. Closing the Performance Gap with Modern C++. In Michaela Taufer, Bernd Mohr, and Julian M. Kunkel, editors, *High Performance Computing: ISC High Performance 2016 International Workshops, ExaComm, E-MuCoCoS, HPC-IODC, IXPUG, IWOPH, P^{3}MA, VHPC, WOPSSS, Frankfurt, Germany, June 19–23, 2016, Revised Selected Papers*, volume 9945 of *Lecture Notes in Computer Science*, pages 18–31. Springer International Publishing, 2016.

Technical reports

Patrick Diehl, Robert Lipton, and Marc Alexander Schweitzer. Numerical verification of a bond-based softening peridynamic model for small displacements: Deducing material parameters from classical linear theory. Technical report, Institut für Numerische Simulation, 2016.

Preprints

Patrick Diehl, Prashant K Jha, Hartmut Kaiser, Robert Lipton, and Martin Levesque. Implementation of Peridynamics utilizing HPX–the C++ standard library for parallelism and concurrency. *arXiv preprint arXiv:1806.06917*, 2018.

Patrick Diehl, Madhavan Seshadri, Thomas Heller, and Hartmut Kaiser. Integration of CUDA Processing within the C++ library for parallelism and concurrency (HPX). *arXiv preprint arXiv:1810.11482*, 2018.

R Tohid, Bibek Wagle, Shahrzad Shirzad, Patrick Diehl, Adrian Serio, Alireza Kheirkhahan, Parsa Amini, Katy Williams, Kate Isaacs, Kevin Huck, et al. Asynchronous Execution of Python Code on Task Based Runtime Systems. *arXiv preprint arXiv:1810.07591*, 2018.

Invited talks and Presentations

Patrick Diehl. Efficient k-nearest neighbor search on the GPU. Seventh International Workshop Meshfree Methods for Partial Differential Equations, 09.09-11.09 2013, Bonn, Germany.

Patrick Diehl. Coupling CPU and GPU to simulate efficient dynamic cracks and fractures in solids. 12th U.S. National Congress on Computational Mechanics (USNCCM12), 21.07-25.07 2013, Reilagh, US.

Patrick Diehl. Simulation of high-speed velocity impact on ceramic materials using the Peridynamic technique. III International Conference on Particle-Based Methods. Fundamentals and Applications. Particles 2013, 18.09-20.09 2013, Stuttgart, Germany.

Patrick Diehl. Simulation of wave propagation and impact damage in brittle materials using the peridynamics technique. 11th. World Congress on Computational Mechanics (WCCM XI), 20.07-25.07 2014, Barcelona, Spain.

Patrick Diehl. Sensivity study for wave propagation and impact damage in brittle materials using peridynamics. ASME International mechanical Engineering Congress and Exposition, 14.11-20.11 2014, Montreal, Canada.

Patrick Diehl. Efficient particle-based simulation of dynamic cracks and fractures in ceramic material. GPU Technology Conference 2014, 24.03-27.03 2014, San Francisco, US.

Patrick Diehl. Simulation of wave propagation and impact damage in brittle materials using the peridynamics technique. 3rd Workshop on Computational Engineering, 06.10-10.10 2014, Stuttgart, Germany.

Patrick Diehl. A sensitivity study for critical traction in quasi-static peridynamics simulations. 1st. PAN-American Congress on Computational Mechanics, 27.04-30.04 2015, Buenos Aires, Argentina.

Patrick Diehl. A benchmark study for mode I crack opening for brittle materials. 13th US National Congress on Computational Mechanics (USNCCM), 26.07-30.07 2015, San Diego, US.

Patrick Diehl. Energy equivalence for the horizon independent bond-based peridynamic softening model according to classical theory. The Mathematics of Finite Elements and Applications 2016 (MAFELAP), 14.06-17.06 2016, London, UK.

Patrick Diehl. Numerical Validation of the bond-based Softening Model. SIAM Mathematical Aspects of Material Science 2016, 07.05-12.05 2016, Philadelphia, US.

Patrick Diehl. Visualization of Fragments, Stress and Fracture Progression in Peridynamics. Isogeometric Analysis and Meshfree Methods, 10.10-12.10 2016, San Diego, USA.

Patrick Diehl. Modeling ductile materials with bond-based softening peridynamic model. 12th. World Congress on Computational Mechanics (WCCM XII), 24.07-29.07 2016, Seoul, Korea.

Patrick Diehl. Modeling and simulation of crack and fractures with peridynamics in brittle materials. HIM Junior Seminar, 08.02. 2017, Bonn, Germany.

Patrick Diehl. Experimental Validation of Elastic State Based Peridynamic for PMMA and epoxy materials. 14th U.S. National Congress on Computational Mechanics (USNCCM14), 17.07-20.07 2017, Montreal, Canada.

Patrick Diehl. A Review for Benchmark Experiments against Peridynamic Models. Nonlocal Methods in Fracture, 15.01-16.01 2018, Austin, USA.

Patrick Diehl. Integration of CUDA Processing within the C++ library for parallelism and concurrency (HPX). IEEE/ACM 4th International Workshop on Extreme Scale Programming Models and Middleware (ESPM2'18), 12.11-16.11 2018, Dallas, USA.

Patrick Diehl. Extracting constitutive mechanical parameters in linear elasticity using the virtual fields method within the ordinary state-based peridynamics framework. Optimization days 2018, 07.05-09.05 2018, Montreal, Canada.

Patrick Diehl. A Review for Benchmark Experiments against Peridynamic Models. 13th. World Congress on Computational Mechanics (WCCM XIII), 23.07-27.07 2018, New York City, US.

Patrick Diehl. Extracting constitutive mechanical parameters in linear elasticity using the virtual fields method within the ordinary state-based peridynamics framework. 18th U.S. National Congress for Theoretical and Applied Mechanics, 04.06-09.06 2018, Rosemont, US.

Thesis

Patrick Diehl. Implementierung eines Peridynamik-Verfahrens auf GPU. Diplomarbeit, Institute of Parallel and Distributed Systems, University of Stuttgart, 2012.

Patrick Diehl. *Modelling and Simulation of cracks and fractures with peridynamics in brittle materials*. Doktorarbeit, University of Bonn, 2017.

Raw experimental data

Ilyass Tabiai, Rolland Delorme, Patrick Diehl, Louis Laberge Lebel, and Martin Levesque. PMMA 3 point bending test until failure loaded in displacement, February 2018.

References

Phd advisers

- Dr. Marc Alexander Schweitzer, Institute for Numerical Simulation, University of Bonn, Germany, E-Mail: schweitzer@ins.uni-bonn.de
- Dr. Daniel Peterseim, Numerische Mathematik, University of Augsburg, Germany, E-Mail: daniel.peterseim@math.uni-augsburg.de

Postdoctoral fellow adviser

- Dr. Serge Prudhomme, Department of Mathematical and Industrial Engineering,Polytechnique Montréal, Canada, E-Mail: serge.prudhomme@polymtl.ca

Collaborators
- Dr. Robert Lipton, Mathematics of Materials Science, Louisiana State University, USA, E-Mail: lipton@math.lsu.edu
- Dr. Thomas Ertl, Visualization and Interactive Systems Institute, University of Stuttgart, Germany, E-Mail: thomas.ertl@vis.uni-stuttgart.de
- Dr. Hartmut Kaiser, Department of Computer Science, Louisiana State University, USA, E-Mail: hkaiser@cct.lsu.edu