

Prashant K. Jha

Research Associate

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(a) Research Interests

My research is driven by the application of mathematics and computational science to present-day relevant and challenging problems. Specific areas of interest include mechanics of solids and granular media, computational oncology, and multiscale modeling.

(b) Education

- B.E. (2006-2010) Mechanical Engineering, Govt. Engineering College, Raipur, India
- M.E. (2010-2012) Mechanical Engineering, Indian Institute of Science, Bangalore, India
Thesis: A monolithic strategy for fluid-structure interaction in compressible flow
Adviser: Dr. Chandrashekhara S. Jog
- Ph.D. (2012-2016) Civil and Environmental Engineering, Carnegie Mellon University, Pittsburgh, USA
Thesis: Coarse graining of electric field interactions with materials
Adviser: Dr. Kaushik Dayal

(c) Research & Professional Experience

- Oct 2016 – Jul 2019 Postdoctoral Fellow, Louisiana State University (PI: Dr. R. Lipton)
- Aug 2019 – Nov 2020 Peter O'Donnell Postdoctoral Fellow, The University of Texas at Austin (PI: Dr. J. T. Oden)
- Dec 2020 – present Research Associate, The University of Texas at Austin (PI: Dr. J. T. Oden)

(d) Publications

Published

1. P. K. **Jha** and R. Lipton, "Finite element approximation of nonlocal dynamic fracture models," *Discrete & Continuous Dynamical Systems-B*, vol. 22, no. 11, p. 0, 2017.
2. P. K. **Jha** and R. Lipton, "Numerical analysis of nonlocal fracture models in holder space," *SIAM Journal on Numerical Analysis*, vol. 56, no. 2, pp. 906–941, 2018.
3. P. K. **Jha** and R. Lipton, "Numerical convergence of nonlinear nonlocal continuum models to local elastodynamics," *International Journal for Numerical Methods in Engineering*, vol. 114, no. 13, pp. 1389–1410, 2018.
4. P. Diehl, P. K. **Jha**, H. Kaiser, R. Lipton, and M. Lévesque, "An asynchronous and task-based implementation of peridynamics utilizing hpx—the c++ standard library for parallelism and concurrency," *SN Applied Sciences*, vol. 2, no. 12, pp. 1–21, 2020.
5. R. Lipton, E. Said, and P. K. **Jha**, "Free damage propagation with memory," *Journal of Elasticity*, vol. 133, no. 2, pp. 129–153, 2018.
6. R. P. Lipton, R. B. Lehoucq, and P. K. **Jha**, "Complex fracture nucleation and evolution with nonlocal elastodynamics," *Journal of Peridynamics and Nonlocal Modeling*, vol. 1, no. 2, pp. 122–130, 2019.
7. P. K. **Jha** and R. Lipton, "Numerical convergence of finite difference approximations for state based peridynamic fracture models," *Computer Methods in Applied Mechanics and Engineering*, vol. 351, pp. 184–225, 2019.
8. P. K. **Jha** and R. Lipton, "Finite element convergence for state-based peridynamic fracture models," *Communications on Applied Mathematics and Computation*, vol. 2, no. 1, pp. 93–128, 2020.
9. P. K. **Jha** and R. P. Lipton, "Kinetic relations and local energy balance for lefm from a nonlocal peridynamic model," *International Journal of Fracture*, vol. 226, no. 1, pp. 81–95, 2020.
10. P. K. **Jha**, L. Cao, and J. T. Oden, "Bayesian-based predictions of covid-19 evolution in texas using multispecies mixture-theoretic continuum models," *Computational Mechanics*, 2020.
11. P. K. **Jha**, P. S. Desai, D. Bhattacharya, and R. Lipton, "Peridynamics-based discrete element method (peridem) model of granular systems involving breakage of arbitrarily shaped particles," *Journal of the Mechanics and Physics of Solids*, vol. 151, p. 104376, 2021.
12. R. P. Lipton and P. K. **Jha**, "Nonlocal elastodynamics and fracture," *Nonlinear Differ. Equ. Appl.* 28, vol. 23, 2021.

13. M. Fritz, P. K. **Jha**, T. Köppl, J. T. Oden, and B. Wohlmuth, “Analysis of a new multispecies tumor growth model coupling 3d phase-fields with a 1d vascular network,” *Nonlinear Analysis: Real World Applications*, vol. 61, p. 103331, 2021.
14. M. Fritz, P. K. **Jha**, T. Köppl, J. T. Oden, A. Wagner, and B. Wohlmuth, “Modeling and simulation of vascular tumors embedded in evolving capillary networks,” *Computer Methods in Applied Mechanics and Engineering*, vol. 384, p. 113975, 2021.
15. D. A. Hormuth, C. M. Phillips, C. Wu, E. A. B. F. Lima, G. Lorenzo, P. K. **Jha**, A. M. Jarrett, J. T. Oden, and T. E. Yankeelov, “Biologically-based mathematical modeling of tumor vasculature and angiogenesis via time-resolved imaging data,” *Cancers*, vol. 13, no. 12, 2021.

Under Review

16. P. K. **Jha**, T. Breitzman, and K. Dayal, “Discrete-to-continuum limits of long-range electrical interactions in nanostructures,” *Preprint: <https://www.math.cmu.edu/cna/Publications/publications2020/papers/20-CNA-020.pdf>*, 2020.
17. P. Gadikar, P. Diehl, and P. K. **Jha**, “Load balancing for distributed nonlocal models within asynchronous many-task systems,” *arXiv preprint arXiv:2102.03819 (conference paper accepted in PDSEC 2021 workshop)*, 2021.

Book Chapters & Reports

18. P. K. **Jha** and R. Lipton, *Well-posed nonlinear nonlocal fracture models associated with double-well potentials*, pp. 1–40. Cham: Springer International Publishing, 2018.
19. P. K. **Jha** and R. Lipton, *Finite differences and finite elements in nonlocal fracture modeling: A priori convergence rates*, pp. 1–38. Cham: Springer International Publishing, 2018.
20. R. Lipton, E. Said, and P. K. **Jha**, *Dynamic brittle fracture from nonlocal double-well potentials: A state-based model*, pp. 1–27. Cham: Springer International Publishing, 2018.
21. R. Lipton, E. Said, and P. K. **Jha**, *Dynamic damage propagation with memory: A state-based model*, pp. 1–29. Cham: Springer International Publishing, 2018.

(e) Major Projects

- **Development of tumor growth model for breast cancer.** Develop a multi-physics model of vascular tumor to determine the patient-specific optimal treatment plan. (In collaboration with the experts at UT Austin and Technical University of Munich).
- **Mechanistic model for HP MRI signal recovery.** Develop model for Hyperpolarized (HP) MRI and formulate optimal experimental design problem for MRI design parameters with uncertainty in the data and the model parameters. (In collaboration with experts at UT Austin and MD Anderson Cancer Center).
- **Peridynamics.** Develop and analyze peridynamics model of continuum solid. Applications include fracture, corrosion, and fatigue.
- **Granular media.** Application of recently proposed high-fidelity model for granular media. Focus includes: 1) understanding change in flow regime, 2) optimization of instruments (e.g., drilling), 3) development of multi-physics engine with applications such as simulation of rover, additive manufacturing process, etc.

(f) Proposals & Grants

1. A mechanistic tumor growth model for HP MRI (Sep 2020 – Aug 2021). Grant awarded under the joint initiative of Oden Institute-MDACC-TACC. In collaboration with MD Anderson Cancer Center.

(g) Open-sourced Software

- **PeriDEM.** Implementation of high-fidelity model (PeriDEM, JMPS 2021) of granular media.
- **NLMech.** Peridynamics simulation library. (With P. Diehl).
- **BayesForSEIRD.** Bayesian calibration and validation of the SEIRD epidemic model. (With L. Cao).
- **Angiogenesis3D1D.** Angiogenesis and tumor growth using 3D-1D model. (With T. Köppl, A. Wagner, M. Fritz).

(h) Professional Activities

Mentoring

- Co-mentored a student working on the development of distributed solver for a nonlocal diffusion equation. Google Summer of Code 2020. [Related github repository](#).

Journal Reviews

CMAME (12 reviews), JMPS (2 reviews), JALCOM (1 review)

Participation in Academic Activities

- Co-organized minisymposium M19 on "Nonlocal models in mathematics and computation" at SIAM TX-LA 3rd Annual Meeting, October 2020.
- One of the nominated candidate for the election of members-at-large for USACM TTA on Mathematical Methods, June 2021.

Talks

1. Seminar: *Coarse graining of electric field interactions with materials*. Mechanical Engineering Seminar, Indian Institute of Science, Bangalore, India. August 2016.
2. Seminar: *Coarse graining of electric field interactions with materials*. Mechanical Engineering Seminar, Indian Institute of Technology, Chennai, India. August 2016.
3. Seminar: *Coarse graining of electric field interactions with materials*. AEM Mechanics Research Seminar, University of Minnesota Twin Cities, Minneapolis, USA. March 2017.
4. Seminar: *Numerical analysis of nonlocal fracture models*. IMA Postdoctoral Seminar, University of Minnesota Twin Cities, Minneapolis, USA. April 2017.
5. Conference: *Numerical analysis of nonlocal fracture models*. US National Congress on Computational Mechanics USNCCM14, Montreal, Canada. July 2017.
6. Seminar: *Finite element approximation of nonlocal fracture models*. Mathematics Department Applied Analysis Seminar, Louisiana State University, Baton Rouge, USA. March 2018.
7. Seminar: *Well-posedness of nonlocal fracture models and apriori error estimates of numerical approximations*. Mathematics Department Seminar, Indian Institute of Science, Bangalore, India. May 2018.
8. Conference: *Free damage propagation with memory*. 13th World Congress in Computational Mechanics, New York, USA. July 2018.
9. Conference: *Convergence results for finite element and finite difference approximation of nonlocal fracture models*. SIAM TX-LA Annual Meeting, Baton Rouge, USA. October 2018.
10. Seminar: *Modelling fracture in solids using nonlocal interaction: A brief overview of Peridynamics*. Mechanical Engineering Seminar, Indian Institute of Technology, Delhi, India. April 2019.
11. Conference: *Convergence results for finite element and finite difference approximation of nonlocal fracture*. ICIAM 2019, Valencia, Spain. July 2019. Presented by Dr. R. Lipton.
12. Conference: *Numerical fracture experiments using nonlinear nonlocal models*. US National Congress on Computational Mechanics USNCCM15, Austin, USA. July 2019.
13. Informal seminar: *Numerical fracture experiments using nonlinear nonlocal models*. Oden Institute, The University of Texas at Austin, Austin, USA. August 2019.
14. Seminar: *A mechanistic tumor growth model for HP MRI*. Center for Computational Oncology Seminar, The University of Texas at Austin, Austin, USA. September 2020.
15. Seminar: *A mechanistic tumor growth model for HP MRI*. Civil and Environmental Engineering Seminar, Carnegie Mellon University, Pittsburgh, USA. October 2020.
16. Seminar: *Application of peridynamics to fracture in solids and granular media*. Special Mechanics Seminar, University of Houston, Houston, USA. October 2020.
17. Conference: *Application of peridynamics to fracture in solids and granular media*. SIAM TX-LA Annual Meeting 2020, USA. October 2020.
18. Seminar: *Application of peridynamics to fracture in solids and granular media*. MAE Seminar Series, University at Buffalo, Buffalo, USA. October 2020.
19. Seminar: *Modeling failure in solids and tissue-scale tumour growth via high-fidelity computational methodologies*. Department Seminar, Department of Computational and Data Science, Indian Institute of Science, Bangalore, India. May 2021.
20. Conference: *Analysis and Application of Peridynamics to Fracture in Solids and Granular Media*. EMI 2021, USA. May 2021.
21. Conference: *Analysis and Application of Peridynamics to Fracture in Solids and Granular Media*. USNCCM 16, USA. July 2021.

(i) Awards & Achievements

- All India rank 31 (957/1000 score) in GATE-2010 exam, India (May 2010)
- Best Teaching Assistant award for the finite element methods course, CEE, CMU (May 2013)
- Peter O'Donnell Postdoctoral Fellowship, Oden Institute, UT Austin (August 2019)

(j) References

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