Jeremy Binagia

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ABOUT ME

Scientist with expertise in physics-based simulation for robotics. I develop high-performance C++ algorithms for fast, high-fidelity simulation, focusing on contact modeling, deformable body dynamics, and Drake-based robotics simulation.

EDUCATION

Stanford University, Ph.D. in Chemical Engineering (4.068 GPA) — 2022
Thesis: *The Impact of Fluid Elasticity on the Motility of Swimming Microorganisms*
Stanford University, M.S. in Chemical Engineering (4.068 GPA) — 2019
The University of Texas at Austin, B.S. in Chemical Engineering with Highest Honors (4.00 GPA) — 2016

RESEARCH EXPERIENCE

Applied Scientist II, Amazon Robotics — 2022 - Present

- Develop and maintain a production-scale robotics simulator using Drake (C++), enabling real-time and batch simulations of Amazon's robotic manipulation workcells
- Write unit and integration tests to validate simulation features; monitor CI pipelines and conduct peer code reviews across multiple collaborative codebases involving large, distributed teams.
- Create high-level design and lead implementation of key features related to asset generation, contact mechanics, deformable objects, and pneumatics
- Routinely collaborate with researchers at Toyota Research Institute (TRI) to design new features related to deformable body simulation in Drake, including occasional open-source contributions
- Investigating scalable ways to generate assets for simulation including photometric 3D reconstruction
- Mentor and advise intern and co-op students who have worked on real2sim and uncertainty quantification

Graduate Researcher, Advisor: Prof. Eric S.G. Shaqfeh, Stanford University — 2016 - 2022

- Developed high-fidelity multiphysics solvers in Fortran for simulating fluid-structure interaction problems, using techniques based on the Finite Element Method (FEM) and parallel MPI-based execution
- Simulated large-deformation continuum mechanics problems involving soft bodies in complex fluids, incorporating nonlinear constitutive models for viscoelastic fluids and deformable bodies (e.g. hyperelastic material)
- Optimized and debugged object-oriented simulation code, leveraging distributed parallel computing via MPI
- Created first fully resolved 3D simulation of microorganisms swimming in complex biological fluids
- Lead a multi-disciplinary team effort with researchers in mechanical engineering to both create and simulate a robotic "swimming rheometer" that can be used to infer properties of complex biofluids
- Effectively communicated results to technical and non-technical audiences alike through oral presentations at various scientific conferences as well as in writing via multiple peer-reviewed publications

High-Energy-Density Physics Intern, Mentor: Dr. Luc Peterson, Lawrence Livermore National Laboratory — 2020

- Conducted radiation hydrodynamics simulations to assess the impact of ablator microstructure on seeding fluid instabilities within inertial confinement fusion (ICF) experiments conducted at the National Ignition Facility (NIF)

SKILLS

Languages (<u>experienced</u> & familiar): <u>C++ (modern, production-quality), Python, MATLAB, Fortran</u>, Lua, R, Mathematica
Software (<u>experienced</u> & familiar): <u>Linux, Git, Drake, Pandas, NumPy, MPI, CUDA</u>, OpenMP, AWS, Bedrock
Theory: Continuum mechanics, Multibody dynamics, Constitutive modeling, Finite element method, Stress-strain relationships, Parallel computing

SELECTED AWARDS & HONORS

Gerald J. Liebermann Fellowship (*awarded to ~13 outstanding Stanford PhD students annually*) — 2021 – 2022
National Science Foundation (NSF) Graduate Research Fellowship (*fund 3 years, valued at $140,000*) — 2016 – 2019
National Defense Science & Engineering Graduate (NDSEG) Fellowship Awardee (*5-10% acceptance rate*) — 2016

SELECTED GRADUATE COURSEWORK

Fluid mechanics:	Microhydrodynamics, Suspension mechanics, Flow instability, Physics of microfluidics
Computational science:	Finite element analysis, Parallel computing, Advanced software development, Numerical methods, Algorithmic analysis, Linear algebra, Cardiovascular computational modeling
Machine learning:	Data mining and analysis, Deep learning, Machine learning in computational engineering

PEER-REVIEWED PUBLICATIONS

1. Pfaff, N., Fu, E., **Binagia, J.,** Isola, P., Tedrake, R., Scalable real2Sim: physics-aware asset generation via robotic pick-and-place setups. *Accepted for IROS 2025*. https://arxiv.org/abs/2503.00370.
2. **Binagia, J.P.*,** Kroo, L.*, Eckman, N., Prakash, M., & Shaqfeh, E. S. G. A swimming rheometer: self-propulsion of a freely-suspended, axisymmetric swimmer by viscoelastic normal stresses. *Journal of Fluid Mechanics* (2022).
3. **Binagia, J. P.,** & Shaqfeh, E. S. G. Self-propulsion of a freely suspended swimmer by a swirling tail in a viscoelastic fluid. *Physical Review Fluids* (2021).
   - Selected as an Editor's Suggestion and featured in a Synopsis article in the magazine "Physics"
4. Housiadas, K. D., **Binagia, J. P.,** & Shaqfeh, E. S. G. Squirmers with swirl in viscoelastic fluids at low Weissenberg number. *Journal of Fluid Mechanics* (2021).
5. **Binagia, J. P**., Phoa, A., Housiadas, K. D. & Shaqfeh, E. S. G. Swimming with swirl in a viscoelastic fluid. *Journal of Fluid Mechanics* (2020).
6. **Binagia, J. P.*,** Guido, C. J.*, Shaqfeh, E. S. G. Three-dimensional simulations of undulatory and amoeboid swimmers in viscoelastic fluids. *Soft Matter* (2019).
7. Shu, C.-C., Tran, V., **Binagia, J.**, Ramkrishna, D. On speeding up stochastic simulations by parallelization of random number generation. *Chemical Engineering Science* (2015).

PATENTS

1. Shaqfeh, E. S. G., Prakash, M., Kroo, L., **Binagia, J.,** A multi-mode mechanical swimmer that acts a rheometer (2024). U.S. Patent App. No. 18/681,312.
2. Bonnecaze, R., Chopra, M., Chopra, S., **Binagia, J.**, Ekerdt, J., & Edmondson, B. Patterning metal regions on metal oxide films/metal films by selective reduction/oxidation using localized thermal heating (2020). U.S. Patent App. No. 16/467,927.

CONFERENCE ORAL PRESENTATIONS

1. **Binagia, J. P.,** & Shaqfeh, E. S. G. Self-propulsion of a freely suspended swimmer by a swirling tail in a viscoelastic fluid. *AIChE Annual Meeting 2021.* Boston, MA (Nov. 2021).
2. **Binagia, J. P.,** Kroo, L., Prakash, M., & Shaqfeh, E. S. G. Self-propulsion of a freely suspended swimmer by a swirling tail in a viscoelastic fluid. *Society of Rheology Annual Meeting.* Bangor, ME (Oct. 2021).
3. **Binagia, J. P.**, Phoa, A., Housiadis, K., & Shaqfeh, E. S. G. The impact of azimuthal flow on swimming dynamics in elastic fluids. *18th International Congress on Rheology (ICR).* Virtual Meeting (Dec. 2020).
4. **Binagia, J. P.**, Phoa, A., Housiadis, K., & Shaqfeh, E. S. G. Swimming with swirl at low Weissenberg number. *APS Division of Fluid Dynamics*. Virtual Meeting (Nov. 2020).
5. **Binagia, J. P.**, & Shaqfeh, E. S. G. Swimming with swirl in a viscoelastic fluid. *AIChE Annual Meeting 2020.* Virtual Meeting (Nov. 2020). Video link: https://youtu.be/STR7URrmcPc
6. **Binagia, J. P.**, & Shaqfeh, E. S. G. Swimming with swirl in a viscoelastic fluid. *Society of Engineering Science*. Virtual Meeting (Sep. 2020).
7. **Binagia, J. P.**, Phoa, A., Housiadis, K., & Shaqfeh, E. S. G. How azimuthal swirl impacts swimming kinematics in a viscoelastic fluid. *APS Division of Fluid Dynamics.* Seattle, WA (2019, Nov).
8. **Binagia, J. P.**, Guido, C. J., & Shaqfeh, E. S. G. Simulating the swimming motion of *C. elegans* and amoeboids in viscoelastic fluids via the immersed boundary method. *SIAM Conference on Computational Science and Engineering*. Spokane, WA (Feb. 2019).

MACHINE LEARNING PROJECTS

Parallel Neural Network Training using Multiple GPUs (github.com/jbinagia/cme213-final-project) 2020

- Designed a parallel algorithm to accelerate neural network training on multiple GPUs via CUDA and MPI

Teaching Microswimmers How to Navigate via Reinforcement Learning (github.com/jbinagia/cme216-final-project) 2020

- Trained theoretical microswimmers (e.g. microrobots) to navigate a complex flow field via reinforcement learning

Efficient Sampling of Equilibrium States Using Artificial Neural Networks (github.com/jbinagia/CS-230-Final-Project) 2019

- Implemented a deep neural network in PyTorch that can efficiently find low energy configurations of molecules

LEADERSHIP & SERVICE

Chair, Dean's Graduate Student Advisory Council (DGSAC) 2021 – 2022
Program Coordinator, Science Teaching Through Art (STAR) 2019 – 2021
Instructor, Stanford Prison Education Project (SPEP) 2019 – 2021

* *These authors contributed equally*