

# YILONG ZHOU, PhD

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## PROFESSIONAL SUMMARY

Physics Simulation Engineer with a Ph.D. in Mechanical Engineering and 8+ years of experience building high-fidelity, large-scale physics simulations for complex dynamical systems. Expertise spans **rigid-body and soft-body dynamics**, **fluid-structure interaction (FSI)**, GPU-accelerated computation, and **ML-augmented simulation**—all directly applicable to legged locomotion, contact-rich terrain interaction, and **sim-to-real transfer**. Core differentiator: the ability to judge whether simulation outputs are physically correct across scale transitions—critical for locomotion where contact models, actuator fidelity, and terrain realism determine whether sim-trained policies transfer to hardware. Proven track record building C++/Python simulation pipelines from scratch, integrating ML with physics models, and closing the fidelity gap against experimental ground truth. Actively developing RL locomotion skills in MuJoCo (PPO/SAC). Experienced with ROS2, Linux HPC, and GPU computing.

## SKILLS

**Simulation & Digital Twin:** COMSOL Multiphysics (FSI, structural mechanics, electrokinetics, thermal), LAMMPS, HOOMD-blue, DeePMD; MuJoCo (active); Rigid-body Dynamics, Soft-body/FSI Simulation, Contact Mechanics, Continuum Mechanics

**Robotics & Control:** Forward/Inverse Kinematics, Trajectory Optimization, Motion Planning, Soft Robotics, ROS2, URDF scene description, Control-oriented Simulation

**ML & Algorithms:** ML Interatomic Potentials (DeePMD/neural-network force fields), Monte Carlo Optimization (C++, from scratch), Surrogate Modeling, Reinforcement Learning (PPO, SAC; MuJoCo + Stable-Baselines3)

**Programming & HPC:** C++, Python, Linux (Ubuntu), Bash, GPU Computing (dual RTX 4090), LBNL Savio HPC, NSF XSEDE (3.42M+ SUs); Ab Initio MD (VASP), DFT

## EDUCATION

<b>Ph.D.</b> , Mechanical Engineering & Materials Science, Duke University, Durham, NC	May 2022
<b>M.S.</b> , Mechanical Engineering, Clemson University, Clemson, SC	Dec. 2016
<b>B.E.</b> , Ocean Engineering, Huazhong University of Science & Technology, Wuhan, China	June 2013

## PROFESSIONAL EXPERIENCE

**Lawrence Berkeley National Laboratory** Berkeley, CA | Jan. 2025 – Present  
*Postdoctoral Scholar, Materials Science Division*

- Built **GPU-accelerated physics simulation** pipelines for constrained multi-body dynamical systems on Linux HPC clusters—directly analogous to legged robot simulation where rigid-body contact, joint constraints, and integration stability are the central challenges; validated fidelity through energy-based stability analysis and trajectory convergence metrics.
- Developed automated pipelines coupling simulation runs with downstream analysis, enabling rapid iteration across parameter spaces—directly applicable to environment tuning, reward shaping, and domain randomization loops in locomotion RL training.

**Lawrence Livermore National Laboratory** Livermore, CA | June 2022 – Nov. 2024  
*Postdoctoral Researcher, Materials Science Division*

- Developed **ML-augmented physics simulation** framework (DeePMD neural-network force fields) bridging quantum-scale ab initio calculations and large-scale molecular dynamics—achieving **100x+ simulation speedup** while preserving physical accuracy; methodology directly analogous to **learned dynamics models and sim-to-real transfer for legged locomotion** in robotic environments. Published in *Physical Chemistry Chemical Physics* (2025, First & Corresponding Author).
- Validated surrogate model accuracy against reference DFT benchmarks across thermodynamic conditions, developing rigorous **simulation fidelity assessment** protocols—the same physical intuition required to evaluate whether a contact-physics or actuator model is trustworthy in robotics simulation.

**Duke University** Durham, NC | Aug. 2017 – May 2022  
*Graduate Research Assistant, Arya Lab*

- Designed and validated 3D FSI simulations in COMSOL Multiphysics for soft robotic actuators:** modeled pneumatically driven balloon actuators under fluid-structure coupling, characterized nonlinear bending dynamics, and used simulation outputs to inform **actuation control strategies**—reducing physical prototyping iterations and demonstrating how high-fidelity physics simulation accelerates design-control co-optimization.
- Pioneered a global Monte Carlo optimization algorithm** implemented in C++ from scratch ([GitHub](#)), solving combinatorial search over complex, multi-modal energy landscapes—directly applicable to motion planning and configuration-space search in robotics. Published in *Nature Communications* (2022, Featured Article).

- Developed **ML-based many-body force-field potentials** for anisotropic systems, achieving 100x+ computational efficiency via surrogate modeling of complex interaction landscapes; published in *npj Computational Materials* (2023).
- Owned the full simulation-to-validation pipeline: collaborated cross-functionally with experimentalists to benchmark model predictions against physical measurements, building rigorous habits for **fidelity verification** that directly transfer to sim-to-real gap assessment in robotics.

## Clemson University

Clemson, SC | Sept. 2013 – Dec. 2016

### Graduate Research Assistant

- Developed **3D COMSOL Multiphysics finite-element models** for coupled-physics structural mechanics in microfluidic systems: electrokinetic transport, Joule heating, and magnetophoretic force fields—building deep COMSOL FEA expertise across multiphysics coupling configurations.
- Validated simulation predictions against experimental measurements from lab-on-chip devices, establishing quantitative accuracy benchmarks.

## OTHER RELEVANT EXPERIENCE

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### Teaching Assistant, Duke University

2019–2020

- Fluid Mechanics & Applied PDEs for 50+ undergraduates; reinforced physical intuition-building in dynamical systems modeling.

### Research Mentor, Clemson University

2014–2016

- Guided 4 students in microfluidics simulation projects; work led to 2 APS conference presentations on electrokinetic flow instabilities.

## GRANTS & AWARDS

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- **NSF XSEDE Grants** (2018–2022): Secured 3.42M+ compute units for large-scale multi-scale simulations—PI-level responsibility for allocating and managing HPC resources.
- **MRS Best Poster Award Nominee** (2024): Recognized for polymer nanocomposite simulation work at Materials Research Society Spring Meeting.
- **MRSEC Director's Publication Award** (2022): High-impact publication on polymer-grafted metal–organic frameworks.

## SELECTED PUBLICATIONS (17 TOTAL, 500+ CITATIONS, H-INDEX: 14)

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- V. Kumar, U. H. Ko, **Y. Zhou**, J. Hoque, G. Arya, S. Varghese. “Microengineered Materials with Self-Healing Features for **Soft Robotics**.” *Advanced Intelligent Systems*, 2021. [Soft robotics FSI — most directly relevant to target roles]
- **Y. Zhou** et al. “Many-body Potential for Simulating the Self-Assembly of Polymer-Grafted Nanoparticles.” *npj Computational Materials*, 2023. [ML surrogate modeling for complex many-body dynamics]
- **Y. Zhou**, G. Arya. “Discovery of Two-Dimensional Binary Nanoparticle Superlattices Using Global Monte Carlo Optimization.” *Nature Communications*, 2022. [C++ optimization algorithm — Featured Article]
- **Y. Zhou** et al. “Simultaneous diamagnetic and magnetic particle trapping in ferrofluid microflows via a single permanent magnet.” *Biomicrofluidics*, 2015. [Coupled-physics COMSOL simulation validated experimentally]

Full list: [scholar.google.com/citations?user=eORlck8AAAAJ](https://scholar.google.com/citations?user=eORlck8AAAAJ)