Hanfeng Zhai

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Education

Cornell University — Ithaca, NY
M.S. in Mechanical Engineering — *Aug. 2021 – June 2023*
Thesis: TBD — Advisor: *Jingjie Yeo*

Shanghai University — Shanghai, China
B.S. in Theoretical and Applied Mechanics (*Outstanding Graduate of Shanghai*) — *Sep. 2017 – July 2021*
Thesis: *Predicting microbubble system dynamics with physics-informed deep learning* — Advisor: *Guohui Hu*

Honors & Awards

Outstanding Undergraduate Thesis Award, *Shanghai University* — *July, 2021*
Outstanding Graduate of Shanghai, *Shanghai Ministry of Education* — *May, 2021*
Second Class Award, *The 3rd Undergraduate Academic Forum of Shanghai University* — *Dec., 2020*
Outstanding Student Nomination, *Shanghai University* — *Dec., 2020*
Top Class Academic Scholarship, *Shanghai University* — *Nov., 2020*
Arts and Sports Scholarship, *Shanghai University* — *Nov., 2020*
Outstanding Undergraduate Course Project, *School of Mechanics and Engineering Science* — *Dec., 2019*
Third Place Award, *Shanghai University Body Building Contest* — *Apr., 2019*
Athletic Scholarship, *Shanghai University* — *Nov., 2018*
First Place Award, *Shanghai University Body Building Contest* — *Apr., 2018*
Outstanding Student, *Bank of China Life* — *Feb., 2018*
Team Award, *IBEP Financial Planning Competition* — *Feb., 2018*
Outstanding Student Nomination, *Shanghai University* — *July, 2018*

Research Experiences

Summer Research Intern — Beijing, China
Institute of Mechanics, Chinese Academy of Sciences; *Supervisor: Xu Zheng* — *May 2021 – Aug 2021*
- Research topic: The role of non-Newtonian fluids on the anomalous diffusion of Janus micromotors
- Fabricated Janus micromotors, designed (with Prof. Zheng) and conducted (with Dr. Wang) the experiments on Janus particles in viscoelastic fluids. Discovered the transnational and rotational diffusion of Janus motors in non-Newtonian fluids.

Research Assistant — Shanghai, China
Shanghai Institute of Applied Mathematics and Mechanics; *Supervisor: Guohui Hu* — *May 2020 – July 2021*
- Research topic: physics-informed deep learning applied to microfluidics and mesoscale fluid mechanics.
- Designed and carried out bubbly flows numerical simulations with biomedical backgrounds in microscale with COMSOL Multiphysics.
- Initiated and proposed BubbleNet, a novel deep learning framework for inferring bubble dynamics with physics-informed neural networks, and open the project on GitHub [4]. Preprint available [5].

Summer Research Intern — Shanghai, China
Shanghai University ; *Supervisor: Bingbing An* — *Jun. 2020 – Aug. 2020*
- Research topic: Numerical study of fatigue and fracture in biomimic and biomaterials.
- Study and show that the plasticity properties of the peritubular dentin structure can effectively resist crack growth of the dentin based on numerical simulations. [Report]

Research Assistant — Shanghai & Seattle (Remote)
Shanghai University & University of Washington; *Supervisor: Dwayne D. Arola* — *Sep. 2019 – Mar. 2020*
- Carried out research in Arola Lab on enamel microstructure fracture resistance investigation and found that the band decussation can effectively resists fracture. [Project Page]
- Writing tech reports and doing presentations directly or remotely with the project principal Dwayne D. Arola.
- Carrying simulations and numerical analysis with Abaqus CAE & Matlab based on the SEM photo of enamel microstructure to analyze the mechanical properties of enamel.

Extracurricular Activities

- **Scientific Editor** for QbitAI.com (Winter 2021). My articles on programmable meta-materials, physics-informed deep learning, etc., reached 25600+ reads, with 150+ likes (June, 2021), which can be viewed at [1], [2], [3], [4], [5].
- **Student Athlete** at China University American Football League (CUAFL). Played Defensive End & Linebacker at *Shanghai University Bombers American Football Team* (2017 – 2019), won 3rd place twice in 2017 – 2018 & 2018 – 2019 seasons [Interview]. Joined Russell Wilson football training camp as a DB. (July, 2018) [Media Coverage].
- **Member** of the Shanghai University Tulip Investment Club (2017 – 2018). Won Team Award & Outstanding Student at Financial Planning Competition hosted at Bank of China Life.
- **Member** of the Shanghai University Bodybuilding Contests (2017 – 2019). Won 1st & 3rd place in Shanghai University 2018 & 2019 Bodybuilding contest.

Selected Projects

Inferring Bubble Dynamics with Physics-Informed Deep Learning Independent Researcher

Research project at SIAMM; *Supervisor: Guohui Hu* *Sep. 2020 – May 2021*

- Carried out several microfluidic numerical simulation of bubbly flow based on the biomedical backgrounds.
- Implemented deep neural network to predict the physics fields (i.e., velocities, pressure, phase.) of the microfluids.
- Proposed a novel deep learning framework inspired by physics-informed neural network to predict bubbly flow and validate that the new framework can predict bubbly flow with higher accuracy.
- The source code can be downloaded through GitHub [1], and paper can be seen from arXiv [2].

Mechanical Properties of Biomaterials Independent Researcher

Projects series on solid mechanics at SHU; *Supervisor: Bingbing An* *Apr. 2020 – Aug. 2020*

- **Structural design of composite materials with superior mechanical behaviors: lesson from the microstructure of nacre and enamel** [Report]
  Course project: CAD Application in Structural Mechanics
  Designed a specific microstructure that displays higher fracture toughness and stiffness inspired from the microstructures of enamel and nacre.
- **Formulation and application of rate-independent stress update algorithm of hydrostatic pressure: elastoplastic yielding in composite.** [Report]
  Course project: Plasticity Theory
  Construct the constitutive model of fibre reinforced composite through rate-independent stress update algorithm, and estimate the fracture influence on the composite.
- **An investigation of the elastoplastic nature of ITD on the toughness of the dentin microstructure.** [Report]
  Shanghai University Summer Research Program
  Designed a specific microstructure that displays higher fracture toughness and stiffness inspired from the microstructures of enamel and nacre.

Publication

[1] **H. Zhai** and G. Hu*. (2021) "BubbleNet: Inferring micro-bubble dynamics with semi-physics-informed deep learning". *arXiv preprint*. arXiv:2105.07179.

Research Presentations

[1] **Computation Methods for Applied Mechanics Problem.** *The 3rd Undergraduate Academic Forum of Shanghai University*. Dec. 30th, 2020. [Poster] [Paper] [News]

Technical Skills

Coding & Programming: Python, MATLAB & Octave, Mathematica, C++, HTML, LaTeX, Bash, MPI, TensorFlow.
Computer Systems: Ubuntu, macOS, Windows 7 & 10.
Simulation Softwares: COMSOL Multiphysics, LAMMPS, ANSYS workbench & APDL, Simulink, Abaqus CAE.
Knowledge & Theories: Computational Fluid Dynamics, Fluid & Solid Mechanics (Elasticity & Plasticity), Structural Mechanics, Machine Learning & Deep Learning, etc.

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