Hanfeng Zhai

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Education

Cornell University — Ithaca, NY
M.S. in Mechanical Engineering — *Sep. 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 – June 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 — *May 2021 – Aug 2021*
Supervisor: Xu Zheng

- 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 (silica-based) and "nano-bullet" (iron-oxide based) in viscoelastic fluids.

Research Assistant — Shanghai, China
Shanghai Institute of Applied Mathematics and Mechanics — *May 2020 – July 2020*
Supervisor: Guohui Hu

- 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].

Scientific Editor Intern — Beijing, China
QbitAI.com — *Jan. 2021 – Feb. 2021*

- Translate research articles assigned by QbitAI instructors from *Nature, Science, PNAS, & Quanta, Phys.org*, etc.
- Wrote five scientific reporting articles on programmable meta-materials, physics-informed deep learning, etc. Assist with sorting out materials with other articles.
- QbitAI is one of the most influential online media on tech news in China. A Top 10 media on reporting research news, based on 2020 Annual Research Media Rankings.
- My articles reached 25600+ reads, with 150+ likes, which can be viewed at [1], [2], [3], [4], [5].

Summer Research Intern — Shanghai, China
Shanghai University — *Jun. 2020 – Aug. 2020*
Supervisor: Bingbing An

- 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 — *Sep. 2019 – Mar. 2020*
Supervisor: Dongsheng Zhang & Dwayne D. Arola

- 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

- **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 Shanghai Institute of Applied Mathematics and Mechanics — *Sep. 2020 – Present*
Supervisor: Guohui Hu

- 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].

Fracture Resistance of Human Enamel Microstructure — Group Member
Research project at Shanghai University — *Sep. 2019 – Mar. 2020*
Supervisor: Dongsheng Zhang and Dwayne D. Arola

- Polished and etch the enamel specimen and observe enamel microstructure through SEM and took photos.
- Proposed a specific band structure based on the SEM photos for enamel microstructure.
- Verifies that the band structure can resist crack growth through simulations carried out by Abaqus CAE.

Mechanical Properties of Biomaterials — Independent Researcher
Projects series on solid mechanics — *Apr. 2020 – Aug. 2020*
Supervisor: Bingbing An

- **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.

Structural Design of Lightweight Compressive Layers Team Leader
Course project: Finite Element Method and Its Applications *Sep. 2019 – Dec. 2019*
Supervisor: Yicheng Song

- Designed different compression structures inspired from traditional Chinese arch bridge and truss structure.
- Built three models by CAD software and 3D printed them successfully.
- Repeated debugging before added a large metal block plate above the test piece to produce uniform loading, and then carried out loading on the test piece.
- Estimated the results of both experiments and simulations and proposed the best design of compressive interlayer.
- The project is nominated "***Outstanding Undergraduate Course Project***". The poster can be viewed on my page, which were displayed at the school hall.

Thermal Estimation of Smartphone Chip Independent Researcher
Course project: Elastic Mechanics *Dec. 2019 – Mar. 2020*
Supervisor: Junqian Zhang

- Model the smartphone with ANSYS workbench with basic structure of battery and chip.
- Construct mathematical derivation and theoretical analysis of chip under thermal field adopting the theory of plate in multiphysics fields.
- Carried out thermal simulation with ANSYS and compare the results with theoretical results.
- Explain how the chip will change undergoes battery's thermal influence from both the results.
- The tech report can be viewed on my page, and I posted a intro video.

Design of Intelligent Tuning Equipment for Stringed Instruments Project Principal
National College Student Innovation and Entrepreneurship Project, No. 201910280001 *Oct. 2019 – Aug. 2020*
Supervisor: Kai Li

- Modeled independently the integrated guitar structure, performed string vibration simulation in ANSYS and specified the effect of the guitar resonance cavity on the overall sound quality and the effect of pitch.
- Designed materials and fixtures according to the theoretical model, and settled on fixing the guitar strings by winding welding to minimize the measurement error under tension.
- Recorded accurately the experimental data, including frequency acquisition of recorded sounds with software.
- Instructed teammate with GUI programs and successfully imported data into MATLAB and Origin Pro for spectrum analysis.
- The details can be viewed on the NCIE website, the report and poster is available on my page.

SOFTWARE

BubbleNet
A deep learning package for inferring microbubble dynamics with physics-informed neural networks.
Environment: Python, MATLAB, TensorFlow. [Website] · [Code] · [Paper] · [Video]
MIT License · DOI:10.5281/zenodo.4679081

PUBLICATION

[1] **H. Zhai** and G. Hu*. (2021) "Inferring micro-bubble dynamics with 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]
[2] **A brief introduction of deep learning algorithms applied to mechanics.** *Prof. Zhansheng Guo's Lab, Shanghai University.* Apr. 20th, 2021. [Slides]

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, Abaqus CAE.
Knowledge & Theories: Computational Fluid Dynamics, Fluid & Solid Mechanics (Elasticity & Plasticity), Structural Mechanics, Machine Learning & Deep Learning, etc.

Hobbies

Bodybuilding, Fitness, Painting, Arts, History, Politics.

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