Han Zhao

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EMPLOYMENT

The Children's Hospital of Philadelphia, Philadelphia, PA — Aug. 2026 - present
Research Associate Scientist II

Impedance pump simulation and design for Fontan circulation

- Built fluid–structure interaction (FSI) models of a valveless impedance pump as a Fontan assist device
- Investigated impedance pump design and operating conditions to optimize pump performance and control flow output, and compared predictions with experiments
- Performed computational fluid dynamics (CFD) simulations in patient-specific Fontan geometries to evaluate hemodynamics

Stanford University, Palo Alto, CA — Oct. 2024 - Aug. 2026
Postdoctoral Scholar in Computational Cardiology

- Built computational models of the aortic valve to support surgical planning and post-op outcome prediction
- Implemented heart valve hemodynamics using the resistive immersed surface (RIS) method, an immersed boundary surface-penalty technique that enables valve opening/closing without remeshing; extended finite element solver svMultiPhysics with heart valve modules and reproducible HPC workflows
- Conducted aortic hemodynamics simulations, delivering clinical relevant metrics for design decisions

EDUCATION

University of California San Diego, La Jolla, CA — Mar. 2020 - Sep. 2024
PhD in Mechanical Engineering
Dissertation topic: Structural analysis and design optimization of non-matching isogeometric shells

University of California San Diego, La Jolla, CA — Sep. 2018 - Mar. 2020
MS in Mechanical Engineering — GPA: 4.0/4.0

Liaoning Technical University, Liaoning, China — Sep. 2014 - Jun. 2018
BEng in Vehicle Engineering — GPA: 3.7/4.0

RESEARCH EXPERIENCE

Automated design-through-analysis for complex aircraft wing structures
Research Assistant (supported by NASA), University of California San Diego — Nov. 2019 - Dec. 2021

- Built a design-through-analysis workflow for complex shell structures directly from CAD models to stress resultants with applications to aircraft wings and heart valve leaflets
- Developed a penalty-based coupling algorithm for non-conforming shells with arbitrary intersections, enforcing displacement and rotational continuity; built an open-source FEniCS-based simulation framework for isogeometric Kirchhoff–Love shells with automated derivative computation
- Delivered a reusable CAD-to-analysis workflow that eliminated manual meshing, achieved comparable analysis accuracy to FEA with 10× fewer degrees of freedom

Gradient-based structural optimization for complex aircraft wing structures
Research Assistant (supported by NASA), University of California San Diego — Jan. 2022 - Sep. 2024

- Developed gradient-based shape and sizing optimization methods for complex wing structures, improved eVTOL wing stiffness and enabling exploration of novel wing configurations

· Implemented free-form deformation (FFD) and Lagrange extraction to preserve integrity across non-conforming isogeometric shells; introduced a shape optimization method for moving shell intersections via implicit formats; developed an open-source toolkit based on OpenMDAO and FEniCS
· Delivered a unified-CAD design–analysis–optimization pipeline for wing structures that eliminates manual FE meshing and remeshing, accelerates optimization cycles, and produces novel eVTOL wing designs

Immersogeometric fluid–structure interaction of trileaflet heart valves
Research Assistant (supported by NASA), University of California San Diego Jan. 2022 - Dec. 2022

· Developed an immersogeometric FSI framework for trileaflet aortic valves that supports physiologic opening/closing with leaflet contact and moving aortic wall
· Modeled aortic wall motion using the arbitrary Lagrangian–Eulerian (ALE) formulation;implemented shell–shell coupling and leaflet contact for multi-patch, non-conforming NURBS leaflets
· Achieved stable leaflet kinematics and realistic transvalvular pressure/flow patterns with physiologically accurate behavior; built open-source modules that accelerate patient-specific valve simulation workflows

Interpolation-based immersed isogeometric analysis for shell structures
Research Assistant, University of California San Diego Mar. 2021 - Oct. 2021

· Implemented an interpolation-based method to approximate isogeometric analysis spline basis functions with lower-order Lagrange polynomials in structural analysis
· Performed structural simulation for complex shell structures using the interpolation-based method; achieved good accuracy with improved efficiency for trimmed NURBS geometry

TEACHING EXPERIENCE

University of California San Diego
Teaching Assistant, MAE232B Finite Element in Solid Mechanics II Jan. 2024 - Mar. 2024
Teaching Assistant, MAE130C Vibrations Jan. 2020 - Mar. 2020
Teaching Assistant, MAE101A Introductory Fluid Mechanics Jul. 2019 - Aug. 2019
Teaching Assistant, MAE131A Solid Mechanics Apr. 2019 - Jun. 2019

· Held office hours to clarify course materials and concepts, delivered lectures, created homework and exam solutions, graded homework and exams with standardized rubrics and timely feedback

AWARDS

Mechanical and Aerospace Engineering Fellowship at UC San Diego Sep. 2020
Outstanding Graduate of Liaoning Province Jun. 2018
First Class Scholarship at Liaoning Technical Univeristy Sep. 2017/ Sep. 2016
National Scholarship Dec. 2016/ Dec. 2015

SERVICES

Mentor, Jacobs Undergraduate Mentoring Program Sep. 2023 - Mar. 2024

· Mentored first-year mechanical engineering undergraduate students to provide advice on research focus, study direction, and course selection

Mentor, the ENLACE summer research program at UC San Diego Jun. 2022 - Jul. 2022

· Delivered lectures on isogeometric analysis to summer research undergraduate students and mentored composite shell structural analysis research projects culminating in a final poster presentation

Journal Reviewer

· International Journal for Numerical Methods in Engineering
· International Journal of Applied Mechanics
· Advances in Engineering Software
· Frontiers of Architectural Research

REFEREED JOURNAL ARTICLES

[1] **H. Zhao**, A. D. Kaiser, F. Kong, A. L. Brown, Z. Hu, D. Codoni, S. Dave, and A. L. Marsden. Comparative analysis of resistive immersed surface and immersed boundary methods for aortic valve simulation. *Under review.*

[2] **H. Zhao**, J. T. Hwang, and J. S. Chen. Open-source shape optimization for isogeometric shells using FEniCS and OpenMDAO. *Engineering with Computers*, 41(3):1877-1899, 2025.

[3] **H. Zhao**, J. T. Hwang, and J. S. Chen. Shape optimization of non-matching isogeometric shells with moving intersections. *Computer Methods in Applied Mechanics and Engineering*, 431:117322, 2024.

[4] **H. Zhao**, D. Kamensky, J. T. Hwang, and J. S. Chen. Automated shape and thickness optimization for non-matching isogeometric shells using free-form deformation. *Engineering with Computers*, 40(6):3495-3518, 2024.

[5] J. E. Fromm, N. Wunsch, R. Xiang, **H. Zhao**, K. Maute, J. A. Evans, and D. Kamensky. Interpolation-based immersed finite element and isogeometric analysis. *Computer Methods in Applied Mechanics and Engineering*, 405:115890, 2023.

[6] G. E. Neighbor, **H. Zhao**, M. Saraeian, M.-C. Hsu, and D. Kamensky. Leveraging code generation for transparent immersogeometric fluid–structure interaction analysis on deforming domains. *Engineering with Computers*, 39(2):1019–1040, 2023.

[7] **H. Zhao**, X. Liu, A. H. Fletcher, R. Xiang, J. T. Hwang, and D. Kamensky. An open-source framework for coupling non-matching isogeometric shells with application to aerospace structures. *Computers & Mathematics with Applications*, 111:109–123, 2022.

[8] X. Liu, C. Du, X. Fu, **H. Zhao**, J. Zhang, and X. Yang. Wear analysis and performance optimization of drum blade in mining coal gangue with shearer. *Engineering Failure Analysis*, 128:105542, 2021.

[9] M. A. Ghanem, A. Khanolkar, **H. Zhao**, and N. Boechler. Nanocontact tailoring via microlensing enables giant postfabrication mesoscopic tuning in a self-assembled ultrasonic metamaterial. *Advanced Functional Materials*, 30(10):1909217, 2020.

REFEREED CONFERENCE PAPERS

[1] S. P. van Schie, M. Ruh, A. H. Fletcher, M. Warner, M. Sperry, L. Scotzniovsky, N. C. Orndorff, R. Xiang, J. Yan, **H. Zhao**, J. Krokowski, J. S. Chen, D. Sarojini, H. Gill, S. Lee, A. C. Tagg, R. Anderson, E. Green, C. Joseph, A. Ning, Z. Cheng, Z. Cao, C. Mi, A. T. Guibert, A. Cronk, A. A. Kim, S. Meng, C. Silva, and J. T. Hwang. Large-Scale Distributed Multidisciplinary Design Optimization of the NASA Lift-Plus-Cruise Air Taxi Concept. *AIAA SciTech 2025 Forum*, 2025.

[2] D. Sarojini, M. Ruh, J. Yan, L. Scotzniovsky, N. C. Orndorff, R. Xiang, **H. Zhao**, J. Krokowski, M. Warner, S. P. van Schie, A. Cronk, A. T. Guibert, J. T. Chambers, L. Wolfe, R. Doring, R. Despins, C. Joseph, R. Anderson, A. Ning, H. Gill, S. Lee, Z. Cheng, Z. Cao, C. Mi, Y. S. Meng, C. Silva, J. S. Chen, A. A. Kim, J. T. Hwang. Review of Computational Models for Large-Scale MDAO of Urban Air Mobility Concepts. *AIAA SciTech 2024 Forum*, 2024.

[3] M. L. Ruh, A. Fletcher, D.Sarojini, M. Sperry, J. Yan, L. Scotzniovsky, S. P. van Schie, M. Warner, N. C. Orndorff, R. Xiang, A. J. Joshy, **H. Zhao**, J. Krokowski, H. Gill, S. Lee, Z. Cheng, Z. Cao, C. Mi, C. Silva, L. Wolfe, J. S. Chen, J. T. Hwang. Large-scale multidisciplinary design optimization of a NASA air taxi concept using a comprehensive physics-based system model. *AIAA SciTech 2024 Forum*, 2024.

[4] S. P. van Schie, **H. Zhao**, J. Yan, R. Xiang, J. T. Hwang, and D. Kamensky. Solver-independent aeroelastic coupling for large-scale multidisciplinary design optimization. *AIAA SciTech 2023 Forum*, 2023.