CHENG-HAU YANG

chenghau@iastate.edu | www.linkedin.com/in/ychenghau | github.com/ChengHauYang

Professional Summary

Ph.D. candidate in Mechanical Engineering with 7+ years of experience in cutting-edge research and software development, specializing in Computational Structural Dynamics (CSD), Computational Fluid Dynamics (CFD), Fluid-Structure Interaction (FSI), and Thermofluids. Expertise in high-performance computing (HPC) using OpenMP and MPI, as well as advanced mesh generation, geometry applications, and visualization tools. Skilled in multiple programming languages, including C, C++, Python, Julia, and Fortran. Adept at integrating machine learning techniques, such as Neural Networks and Bayesian Optimization, into scientific computing. Proven track record of cross-disciplinary collaboration with teams in fields like computer science, electrical engineering, materials science, and architecture to deliver innovative solutions. Known for driving efficiency and scalability in large-scale simulations.

Education

- **Iowa State University (ISU)**, Ames, Iowa, GPA: 3.93/4 (Dean Fellowship recipient) 08/2019-01/2025
  Doctor of Philosophy, Ph.D., Mechanical Engineering, Minor in Applied Mathematics
- **National Taiwan University (NTU)**, Taipei City, Taiwan, GPA: 3.92/4.3 07/2014–06/2016
  Master of Science, M.S., Mechanical Engineering
- **National Cheng Kung University (NCKU)**, Tainan, Taiwan, GPA: 3.8/4 (ranking: 2nd/59) 09/2010–06/2014
  Bachelor of Science, B.S., Mechanical Engineering

Skills

- Programming: C, C++, Fortran, Julia, Python, and MATLAB
- Mesh generation tools: ANSA, Gmsh, Netgen, and DistMesh
- CAD Design Software: AutoCAD, SOLIDWORKS, Rhino, and Grasshopper
- Simulation Software: ANSYS Fluent, COMSOL, and Abaqus
- Visualization tools: Tecplot and ParaView
- Build Systems: CMake and Make
- Containers: Docker
- Version Control: Git, GitHub, and Bitbucket

Work Experience

PhD Residency, X (formerly Google X), Google LLC, California, USA 08/2023-12/2023

- **Parasitic extraction (PEX)**
  - Parallelly solve PDEs using deal.II with MPI for distributed computing.
  - Revamped the meshing component of the code by shifting from Gmsh API to Protobuf, effectively eliminating the need for meshing in every run.
  - Enhanced code maintainability and reliability by integrating support with GoogleTest.
- **Geometry optimization**
  - Developed a re-meshing-free optimization technique, boosting scalability and reducing iteration time by 50%.
  - Achieved a 50% reduction in time for each optimization iteration, markedly enhancing process efficiency.

Research Experience

Advanced Material Division, Argonne National Lab, Illinois, USA 03/2025-present

- Contributed to the development of the FEM software MOOSE by improving solver convergence and enhancing its user interface. (PR example)
- Integrated the Shifted Boundary Method (SBM) into MOOSE to facilitate accurate welding simulations.

Computational Physics Research Assistant, ISU, ComPM Lab, Iowa, USA 01/2021-01/2025

- **Linear Elasticity PDE Solver using Finite Cell Method.**
  - Developed Galerkin finite element integrations within a parallel octree-based framework using MPI, validated Von Mises stress against Abaqus, and published results.
- **Quenching problem using Immersed Boundary Method.**
  - Designed an efficient Grasshopper framework for generating and merging variable-sized spheres to model molecular geometries, reducing computation time and accurately computing Van der Waals molecular volumes from input data.
- **Non-Newtonian two-phase flow simulation for personalized sensors design.**
  - Simulated Navier-Stokes and Cahn-Hilliard coupled pulsating jets [Pulsating Jet Simulation Video] using HPC, implementing a non-Newtonian framework verified through bubble-rising cases.
  - Modeled strain-rate and viscosity relations using PyTorch neural networks (NN).
- **Navier Stokes and Heat Transfer coupled building simulations.**

- Studied ET (Evapotranspiration) effects and tree blockage on energy transfer in buildings, iteratively developing Nusselt number correlations using Bayesian Optimization (BO).

- **Shifted Boundary Method (SBM).**
  - Achieved parallel execution across 1280 processors with near-optimal scaling, enabling large-scale simulations with billions of degrees of freedom for Poisson's and linear elasticity equations.
  - Improved SBM accuracy by 50% with optimal surrogate boundaries, applied to complex geometries like the Stanford Bunny and Eiffel Tower.
  - Speeded up simulations 10X faster for distance calculations using K-D Tree.
  - Applied the SBM framework with LES and VMS to the Navier-Stokes equations, showcasing its advantages in turbulent flows. [Flow Passing a Sphere Video]
  - Applied the SBM to thermal flow for the first time and, with the support of dynamic adaptive mesh refinement, achieved efficient and accurate simulations. [Natural convection past a star-shaped domain]
  - First time applying SBM to thin shell geometries, which resolves the (a) issues with the blockage effect (b) reliance on the penalty approach in IMGA. [Flow past thin plates and circular disk in 2D]

Computational Physics Research Assistant, ISU, CFSI Lab, Iowa, USA 08/2019-01/2021

- **BHV (Bioprosthetic heart valve) simulation using FEniCS.**
  - Performed FSI simulations for various heart valve geometries using FEniCS.
- **One-way-coupling fluid-structure simulation of left ventricular using IMGA (Immersogeometric Analysis).**
  - Enhanced in-house code from two-way to one-way coupling, expanding support for more geometry formats. [Left Ventricular Simulation Video]
- **TAVR (Transcatheter aortic valve replacement) simulation.**
  - Optimized meshing code, reducing generation and refinement steps to a one-click process.
- **Structure simulation using the penalty method.**
  - Automated identification of 300+ curves to connect 200+ patches using Grasshopper.
- **Leaflet flutter simulation.**
  - Identified bending stiffness as the primary factor influencing leaflet flutter.

Honors & Awards

- Research Excellence Award, Iowa State University 2025
- USACM Travel Award, U.S. Association for Computational Mechanics 2024
- NATPA 2021 Poster Award, North America Taiwanese Professors' Association 2021
- Dean Fellowship (Appointed as a Graduate Dean Scholar), Iowa State University 2019
- Outstanding Student Award for Academic Achievement*2, National Cheng Kung University 2011,2012
- Remarkable Achievement Award for Calculus Contest, National Cheng Kung University 2011
- Taipower Scholarship, Taiwan Power Company 2011-2016

Selected Publications

1. **Yang CH**, Saurabh K, Scovazzi G, Canuto C, Krishnamurthy A, Ganapathysubramanian B. Optimal surrogate boundary selection and scalability studies for the shifted boundary method on octree meshes. Computer Methods in Applied Mechanics and Engineering. 2024 Feb 1;419:116686.
2. **Yang CH**, Scovazzi G, Krishnamurthy A, Ganapathysubramanian B. Simulating incompressible flows over complex geometries using the shifted boundary method with incomplete adaptive octree meshes. arXiv preprint arXiv:2411.00272.
3. **Yang CH**, Scovazzi G, Krishnamurthy A, Ganapathysubramanian B. Octree-Based Shifted Boundary Method for Multiphysics Simulations Using Linearized Navier-Stokes in Complex Geometries. arXiv preprint arXiv:2501.00143.
4. **Yang CH**, Scovazzi G, Krishnamurthy A, Ganapathysubramanian B. Octree-based adaptive mesh refinement and the shifted boundary method for efficient fluid dynamics simulations. Advances in Computational Science and Engineering. 2025;4(0):57–84. doi:10.3934/acse.2025012.
5. **Yang CH**, Scovazzi G, Krishnamurthy A, Ganapathysubramanian B. Shifted Boundary Method on Octree Meshes for Accurate Flow Simulations Around Thin Shell Structures. In preparation.
6. Tali R, Rabeh A, **Yang CH (co-first author)**, Shadkhah M, Karki S, Upadhyaya A, Dhakshinamoorthy S, Saadati M, Sarkar S, Krishnamurthy A, Hegde C, Balu A, Ganapathysubramanian B. FlowBench: A Large Scale Benchmark for Flow Simulation over Complex Geometries. Accepted by DMLR (Data-centric Machine Learning Research). [Project page]
7. Tan K, Gao B, **Yang CH**, Johnson EL, Hsu MC, Passalacqua A, Krishnamurthy A, Ganapathysubramanian B. A computational framework for transmission risk assessment of aerosolized particles in classrooms. Engineering with Computers. 2024 Feb;40(1):235-56.

8. Johnson EL, Rajanna MR, **Yang CH**, Hsu MC. Effects of membrane and flexural stiffnesses on aortic valve dynamics: identifying the mechanics of leaflet flutter in thinner biological tissues. Forces in mechanics. 2022 Feb 1;6:100053.
9. Xu F, Johnson EL, Wang C, Jafari A, **Yang CH**, Sacks MS, Krishnamurthy A, Hsu MC. Computational investigation of left ventricular hemodynamics following bioprosthetic aortic and mitral valve replacement. Mechanics Research Communications. 2021 Mar 1;112:103604.
10. Heisler E, **Yang CH**, Deshmukh A, Ganapathysubramanian B, Sundar H. Generating Finite Element Codes combining Adaptive Octrees with Complex Geometries. arXiv preprint arXiv:2305.19398. 2023 May 30.
11. Shadkhah M, **Yang CH**, Karki S, Ganapathysubramanian B. Octree-Based Shifted Boundary Method: Evaluating the Impact of Hanging-Node Removal on Convergence and Solver Performance for Linear PDEs. Submitted.
12. Shadkhah M, Tali R, Rabeh A, Herron E, **Yang CH**, Upadhyaya A, Krishnamurthy A, Hegde C, Balu A, Ganapathysubramanian B. MPF-Bench: A Large Scale Dataset for SciML of Multi-Phase-Flows: Droplet and Bubble Dynamics. Submitted
13. Muralidharan V, **Yang CH**, Passe U, Ganapathysubramanian B. Modeling the Impact of Trees on Building Energy Use: A Novel Approach using CFD and EnergyPlus. In preparation.

Selected Presentations

1. **Yang CH**, Scovazzi G, Krishnamurthy A, Ganapathysubramanian B. Shifted Boundary Method for flow simulations over complex objects, World Congress on Computational Mechanics, 2024
2. **Yang CH**, Saurabh K, Scovazzi G, Krishnamurthy A, Ganapathysubramanian B. Optimal surrogate boundary of complex CAD models for solving PDEs using the shifted boundary method, US National Congress on Computational Mechanics, Page 1090, 2023.
3. **Yang CH**, Saurabh K, Sundar H, Krishnamurthy A, Ganapathysubramanian B. Massively parallel implementation of the finite cell method on incomplete octrees, US National Congress on Computational Mechanics, Page 785, 2021.
4. **Yang CH**, Khanwale M, Saurabh K, Sundar H, Krishnamurthy A, Ganapathysubramanian B. Two-phase simulation of 3D pulsating jet breakup using the scalable adaptive finite element method, CoMFRE conference, 2021.