James Gabbard

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I am a doctoral candidate studying mechanical engineering and computational science at the Massachusetts Institute of Technology. My work focuses on efficient and scalable algorithms for fluid simulations with embedded boundaries.

EDUCATION

Massachusetts Institute of Technology — Boston, MA
Candidate for PhD in Mechanical Engineering and Computation — Expected 2024
SM in Mechanical Engineering — Feb. 2020
Cumulative GPA: 5.0/5.0

University of Southern California — Los Angeles, CA
B.S. Mechanical Engineering and B.S. Applied and Computational Mathematics — May 2018
Cumulative GPA: 3.99/4.00

RESEARCH PROJECTS

Immersed Interface methods for Tightly Coupled Multiphysics Simulations — Ongoing
Graduate Research Assistant, MIT Van Rees Lab

- Developed novel techniques for treating interface jump conditions in finite difference schemes.
- Implemented immersed interface methods within distributed-memory framework written in C++.
- Explored the conservation properties of lifted wavelet transforms on block-structured multiresolution grids and their utility in time-dependent PDE solvers.

An Embedded Boundary Space-time Finite Volume Methods for Ice Sheet Modeling — Summer 2022
Summer Research Associate, Lawrence Berkeley National Laboratory

- Developed high-order conservative numerical methods for simulations with moving boundaries
- Developed efficient geometry processing algorithms for cut-cell finite volume methods

An Immersed Interface Method for 2D Flows with Moving Boundaries — Aug. 2018 – May 2021
Graduate Research Assistant, MIT Van Rees Lab

- Implemented a multithreaded vorticity-based 2D Navier-Stokes solver in C++.
- Added support for arbitrary geometries on Cartesian grids using an immersed interface method.
- Extended existing Immersed Interface techniques to allow simulations of multiple moving bodies and second-order accurate estimation of surface shear and pressure distributions.

Numerical Methods and Optimization for Biological Propulsion — Feb. 2019 – May 2020
Graduate Research Assistant, MIT Van Rees Lab

- Implemented a boundary element potential flow solver, the Discrete Elastic Rods framework, and a nonlinear elastic membrane solver in MATLAB.
- Coupled these solvers to simulate the mechanics of ray-finned fish and membrane wings.
- Leveraged genetic algorithms for optimizing structural parameters of artificial wings and fins.

Kinetic Energy Recovery System for Human Powered Vehicle Racing — Aug. 2017 – Dec. 2017
Senior Design Project, USC Viterbi School of Engineering

- Designed, manufactured, and tested a flywheel energy storage system
- Developed and a system model to predict performance under real-world operating conditions

TEACHING EXPERIENCE

MIT 2.086: Numerical Computation for Mechanical Engineers Aug. 2020 – Dec. 2020
Teaching Assistant

- Worked closely with undergraduate students during weekly lab sessions and office hours.
- Wrote computational problem sets with an emphasis on real-world engineering applications

INDUSTRY EXPERIENCE

New Hampshire Ball Bearings Chatsworth, CA
Mechanical Engineering / Mathematics Intern Summer 2017

- Implemented numerical solvers and curve fitting to optimize cutting surfaces for CNC tooling.
- Created spreadsheets to estimate lubricant film thickness and forging loads for bearing retainers.

Beckman Coulter Brea, CA
Human Factors/Usability Engineering Intern Summer 2016

- Created and documented SolidWorks assemblies of over 600 unique parts for medical devices.
- Performed qualitative analysis of data from usability studies to determine sources of user error.

JBS International Burlingame, CA
Research Assistant Summer 2015

- Coded survey responses and performed qualitative data analysis on survey data.
- Summarized evaluation reports for a literature review on the impacts of AmeriCorps program.

PUBLICATIONS

J. Gabbard, T. Gillis, P. Chatelain, W. M. van Rees. An immersed interface method for the 2D vorticity-velocity Navier-Stokes equations with multiple bodies. Journal of Computational Physics, 2022.

J. Gabbard. "An immersed interface method for incompressible flow with moving boundaries and high order time integration." Master's Thesis, Massachusetts Institute of Technology, Feb. 2020

B. Conrey, **J. Gabbard**, K. Grant, A. Liu, K. Morrison. "Intransitive Dice." Mathematics Magazine, Apr. 2016.

TALKS

J. Gabbard, W. M. van Rees. "A High-Order Immersed Interface Method for 3D Transport Equations." Conference presentation for the APS Division of Fluid Dynamics, Nov. 2022.

J. Gabbard, T. Gillis, W. M. van Rees. "Implementation and Scalability of a High-Order Immersed Interface Method on HPC Architectures." SIAM Conference on Parallel Processing, Feb. 2022

J. Gabbard, W. M. van Rees. "An immersed interface vortex method for internal and external 2D flows with moving boundaries." Conference presentation for the APS Division of Fluid Dynamics, Nov. 2020.

J. Gabbard. "The immersed interface method accurately simulates 2D fluid flows in complex moving domains." Poster and lightning talk for the MIT MechE Research Exhibition, Oct. 2020.

AWARDS AND RECOGNITION

MIT MechE Research Exhibition: Best Lighting Talk Oct. 2020
MathWorks Engineering Fellowship Aug. 2019 – Aug. 2020
MAA Carl B. Allendoerfer Award (Mathematics Magazine) July 2017
USC Presidential Scholarship Aug. 2014 – May 2018
National Merit Scholarship Aug. 2014 – May 2018

SKILLS

Languages: C++, Python, Julia, GNU Make, CMake, MATLAB, Scheme
Applications: OpenFoam, ParaView, SolidWorks, Siemens NX