

Jiacheng Zhang

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RESEARCH INTERESTS

- Data augmentation and enhancement for flow measurement
- 4D flow magnetic resonance imaging (MRI) and processing
- Cardiovascular fluid mechanics and hemodynamics
- Image-based flow measurement techniques such as Particle Imaging Velocimetry (PIV), Particle Tracking Velocimetry (PTV), and Background Oriented Schlieren (BOS)
- Computational fluid dynamics
- Combustion and combustion modeling

EDUCATION

Doctor of Philosophy in Mechanical Engineering May 2022 (expected)
School of Mechanical Engineering, Purdue University, West Lafayette, IN, USA
Dissertation: Data augmentation and enhancement for cardiovascular 4D flow MRI

Master of Science in Mechanical Engineering August 2015
School of Mechanical Engineering, Purdue University, West Lafayette, IN, USA
Thesis: A numerical study of laminar flames propagating in stratified mixtures

Bachelor of Science in Mechanical Engineering July 2014
School of Mechanical Engineering, Shanghai Jiao Tong University (SJTU), Shanghai, China

RESEARCH EXPERIENCE

School of Mechanical Engineering, Purdue University West Lafayette, IN
Research Assistant August 2015 to present

Advisor: Pavlos P. Vlachos, PhD

- Developed the processing and reconstruction algorithms for 4D flow magnetic resonance imaging (MRI) to improve the reliability of the blood flow measurement and hemodynamic evaluation.
- Enhanced the resolution and accuracy of 4D flow MRI using a multi-modality data fusion approach with machine learning algorithm.
- Developed advanced least-squares methods for the estimation of pressure distribution, density field, and wall shear stress from flow measurements with more than 100% improvement in accuracy.
- Invented a novel image analysis framework to measure the concentration-dependent diffusion coefficients from a sequence of images of molecules diffusion.
- Quantified the uncertainty of various image-based measurement techniques.
- Performed the visualization, processing, and statistical analysis of time-dependent, multi-dimensional images, signals, and data.
- Mentored and trained graduate students. Assisted in lab management and code organization.
- Collaborated with clinical partners on processing and analyzing MRI and echocardiogram data.

- Provided the preliminary data and assisted in writing grant proposals.

School of Mechanical Engineering, Purdue University
Research Assistant

West Lafayette, IN
 October 2014 to August 2015

Advisor: John Abraham, PhD

- Conducted computational fluid dynamics (CFD) simulations of flame propagation in stratified fuel-air mixtures and investigated the effect of stratification on laminar flame propagation speed.
- Implemented numerical models to analyze the effect of compositional stratification on the flammability limit.

National Lab of Internal Combustion Engine, SJTU
Undergraduate Researcher

Shanghai, China
 February 2013 – July 2013

- Conducted the 3-D modeling of fuel injection spray with Ansys Fluent and analyzed the spray characteristics of different fuels.
- Assisted in the experimental measurement of spray penetration and cone-angle using high-speed photography.

TEACHING EXPERIENCE

School of Mechanical Engineering, Purdue University
Teaching Assistant

West Lafayette, IN
 January 2015 to May 2019

Course: Fluid Mechanics

- Held weekly teaching sessions, lab hours, and tutoring hours.
- Assisted in developing course material and grading assignments, lab reports, and exams.
- Served as the lead teaching assistant to organize weekly meetings and tasks among fellow teaching assistants.

JOURNAL PUBLICATIONS

Zhang, J., Bhattacharya, S., & Vlachos, P. P. (2022). Uncertainty of PIV/PTV based Eulerian pressure estimation using velocity uncertainty. *Measurement Science and Technology*, 33(6), 065303. <https://doi.org/10.1088/1361-6501/ac56bf>

Zhang, J., Brindise, M. C., Rothenberger, S. M., Markl, M., Rayz, V. L., & Vlachos, P. P. (2022). A multi-modality approach for enhancing 4D flow magnetic resonance imaging via sparse representation. *Journal of The Royal Society Interface*, 19(186). <https://doi.org/10.1098/rsif.2021.0751>

Rothenberger, S. M., **Zhang, J.**, Brindise, M. C., Schnell, S., Markl, M., Vlachos, P. P., & Rayz, V. L. (2022). Modeling Bias Error in 4D flow MRI Velocity Measurements. *IEEE Transactions on Medical Imaging*, xx(X), 1–1. <https://doi.org/10.1109/TMI.2022.3149421>

Zhang, J., Rothenberger, S. M., Brindise, M. C., Scott, M. B., Berhane, H., Baraboo, J. J., Markl, M., Rayz, V. L., & Vlachos, P. P. (2021). Divergence-Free Constrained Phase Unwrapping and Denoising for 4D Flow MRI Using Weighted Least-Squares. *IEEE Transactions on Medical Imaging*, 40(12), 3389–3399. <https://doi.org/10.1109/TMI.2021.3086331>

- Rajendran, L.*, **Zhang, J.***, Bane, S., & Vlachos, P. (2020). Uncertainty-based weighted least squares density integration for background-oriented schlieren. *Experiments in Fluids*, 61(11), 239. <https://doi.org/10.1007/s00348-020-03071-w>
- Zhang, J.**, Bhattacharya, S., & Vlachos, P. P. (2020). Using uncertainty to improve pressure field reconstruction from PIV/PTV flow measurements. *Experiments in Fluids*, 61(6), 131. <https://doi.org/10.1007/s00348-020-02974-y>
- Rajendran, L. K., **Zhang, J.**, Bhattacharya, S., Bane, S. P. M., & Vlachos, P. P. (2020). Uncertainty quantification in density estimation from background-oriented Schlieren measurements. *Measurement Science and Technology*, 31(5), 054002. <https://doi.org/10.1088/1361-6501/ab60c8>
- Singh, B., Rajendran, L. K., **Zhang, J.**, Vlachos, P. P., & Bane, S. P. M. (2020). Vortex rings drive entrainment and cooling in flow induced by a spark discharge. *Physical Review Fluids*, 5(11), 114501. <https://doi.org/10.1103/PhysRevFluids.5.114501>
- Zhang, J.**, Brindise, M. C., Rothenberger, S., Schnell, S., Markl, M., Saloner, D., Rayz, V. L., & Vlachos, P. P. (2020). 4D Flow MRI Pressure Estimation Using Velocity Measurement-Error-Based Weighted Least-Squares. *IEEE Transactions on Medical Imaging*, 39(5), 1668–1680. <https://doi.org/10.1109/TMI.2019.2954697>
- Acuna, A., Berman, A. G., Damen, F. W., Meyers, B. A., Adelsperger, A. R., Bayer, K. C., Brindise, M. C., Bungart, B., Kiel, A. M., Morrison, R. A., Muskat, J. C., Wasilczuk, K. M., Wen, Y., **Zhang, J.**, Zito, P., & Goergen, C. J. (2018). Computational Fluid Dynamics of Vascular Disease in Animal Models. *Journal of Biomechanical Engineering*, 140(8), 1–14. <https://doi.org/10.1115/1.4039678>
- Zhang, J.**, & Abraham, J. (2016). A numerical study of laminar flames propagating in stratified mixtures. *Combustion and Flame*, 163, 461–471. <https://doi.org/10.1016/j.combustflame.2015.10.020>

* indicates shared co-authorship between primary authors

CONFERENCE PRESENTATIONS

“Uncertainty of PIV/PTV based pressure, using velocity uncertainty”, 14th International Symposium on Particle Image Velocimetry – ISPIV 2021, Aug 1-5, 2021, Chicago, IL, USA

“Numerical Uncertainty in Density Estimation for Background Oriented Schlieren”, 14th International Symposium on Particle Image Velocimetry – ISPIV 2021, Aug 1-5, 2021, Chicago, IL, USA

“A multi-modality approach for enhancing 4D flow MRI in cerebral aneurysms via sparse representation”, 73rd Annual Meeting of the APS Division of Fluid Dynamics, Nov 22-24, 2020, Virtual

“Pressure reconstruction using velocity measurement-error based generalized least-squares”, 71st Annual Meeting of the APS Division of Fluid Dynamics, Nov 18-20, 2018, Atlanta, Georgia, USA

“Instantaneous Pressure Field Calculation from PIV Data with Least-Square Reconstruction”, 69th Annual Meeting of the APS Division of Fluid Dynamics, Nov 20-22, 2016, Portland, Oregon, USA

“Simulations of laminar flames propagating in stratified mixtures”, 9th U.S. National Combustion Meeting, May 17-20, 2015, Cincinnati, Ohio, USA

HONORS AND AWARDS

Robert Isaac Rheinstrom Memorial Scholarship, Purdue University, September 2014

Dean's List & Semester Honors for outstanding scholastic performance, Purdue University, Feb 2014

LiuGong Scholarship (Academic excellence) of SJTU, December 2012

Mechanical Engineering Scholarship of SJTU, December 2012

YiHai Kerry Scholarship of SJTU, December 2011

PATENT AND INTELLECTUAL PROPERTY

A Method for Wall Shear Stress Estimation with Navier Stokes Equation Correction (IP disclosure, 2022-VLAC-69750)

3D Spatial-Temporal Solver for Concentration Dependent Diffusion Coefficient (IP disclosure, 2022-VLAC-69713)

Spatial-Temporal Solver for Concentration Dependent Diffusion Coefficient (IP disclosure, 2021-VLAC-69331)

Flow-physics Constrained Phase Unwrapping and Denoising for 4D Flow MRI (IP disclosure, 2020-VLAC-69043)

Dual Patient Ventilation Model for ARDS COVID-19 Crisis Response (IP disclosure, 2020-VLAC-69028)

RESEARCH GRANT

Risk Assessment of Cerebral Aneurysm Growth with 4D flow MRI

National Institutes of Health, R01 HL115267, 09/2013 to 07/2024

PIs: Ansari, Sameer A.; Lawton, Michael T.; Rayz, Vitaliy L.; Saloner, David A.; Vlachos, Pavlos P.

Role: research assistant

Multi-modality 4D Flow MRI data enhancement for quantification of cerebral aneurysms hemodynamics

National Institutes of Health, R21 NS106696, 06/2018 to 05/2021

PIs: Rayz, Vitaliy L.; Schnell, Susanne

Role: research assistant