WENZHUO XU

Ph.D. Candidate in Mechanical Engineering

(412) 979-9932 wzxu@cmu.edu wenzhuoxu.com WenzhuoXu

EDUCATION

Ph.D. in Mechanical Engineering Expected May 2027
Carnegie Mellon University, Pittsburgh, PA
Advisors: Dr. Christopher McComb, Dr. Noelia Grande Gutiérrez

M.S. in Mechanical Engineering August 2024
Carnegie Mellon University, Pittsburgh, PA
Earned en route to Ph.D.

B.Eng. in Mechanical Engineering & B.A. in German June 2022
Shanghai Jiao Tong University, Shanghai, China
Dual-degree program

EXPERIENCE

Research Scientist Intern
Adobe Research May 2026–Aug 2026
Advisors: Tong Sun, Jiuxiang Gu, Joseph K J, Xuechen Zhang

VeriPhy: Agentic Physical Reasoning for World Model Evaluation and Refinement

arXiv:2609.03153 • project page

- Built an auditable video critic: a reasoning model compiles the prompt into typed physical obligations, frozen operators (SAM 3 tracking, counting, motion, depth, OCR, audio) measure them, and fixed rules compose per-claim verdicts
- Finds 228 of 304 human-marked flaws (75.0%) on the 149-clip core, against 164 (53.9%) for a question-decomposition evaluator on identical clips and claims — at 14.1 tool calls per clip, not 21.9
- Ranks clips closer to human ratings than VideoScore2: SRCC 0.465 against 0.327 on 200 VideoPhy-2 clips (paired $+0.138$, 95% $[+0.005, +0.277]$)
- Lessons distilled from recorded misses lift held-out recall from 340 to 375 of 502 flaws ($p = 3 \times 10^{-4}$) with no weight update, saturating at 25 experience clips
- Held-out Physion-Eval (601 clips): 18.4% matched-report rate and a 26.8% evidence-conditioned flag rate, against 1.2–16.9% for the benchmark's ten VLM critics

Project Still Life: Document-Grounded Generation of Verified Interactive and Photoreal Figures

In preparation

- Built a pipeline turning a document's printed physics into runnable figures: a document graph expanded to a closure predicate, compiled to a scenario card, drawn into the figure's own rectangle behind five formal gates
- Designed FCR-Bench, scoring retrieval against each equation's dependency closure: over 418 documents and 142,675 queries, sufficiency@10 of 31.4% against 21.0% for dense retrieval and 0.449 against 0.105 non-local recall
- Beat single-call generation figure by figure: 0.923 against 0.389 on 26 figures and eight questions each, 17 wins to 0 losses ($p = 1.5 \times 10^{-5}$), matching the printed figure's 0.942
- Animated the chapter's own photograph from the gated simulation: periods within 1.1–4.5% of the closed form under two independent trackers, against 23.5% for prompt-only Veo 3.1 and no recoverable period unconditioned
- Fixed the conditioning-release step by sweep — step 14 of 40 holds trajectory correlation above 0.99 while photographic appearance returns — across seven gated scenario families and a 1,314-scene library

Graduate Research Assistant
Carnegie Mellon University Oct 2022–Present
Advisors: Dr. Christopher McComb, Dr. Noelia Grande Gutiérrez

Engineering Super-resolution of Autonomous Digital Design (ADD)

Collaboration with Eaton Research Labs and ERDC • JCISE 2026 • IDETC-CIE 2025 • project page

- Constructed a fully parameterized CFD dataset with 100,000+ flow field simulations featuring varying geometries and boundary conditions
- Designed generalizable super-resolution ML algorithm maintaining <5% error in key flow quantities
- Successfully deployed in Eaton's jet engine duct system design workflow

Domain Decomposition for Large-scale Physics-informed Machine Learning

Manufacturing Futures Institute Initiative • J. Comput. Phys. 2025 • Computers & Fluids 2026 • project page

- First ML method scaling PINNs to 3+ million physical elements
- Proposed spectrum encoding for measuring domain shift across physics regimes
- Deployed to metal additive manufacturing and cardiovascular simulations
- Outperformed traditional FEM solvers while maintaining accuracy standards

Graph Neural Operator Super-Resolution for Vascular Hemodynamics

BioSimulation Lab • J. Comput. Phys. 2025 • project page

- Developed a discrete formulation of TEECNet using a branch-trunk architecture with Taylor-series expansion on bounded velocity proxies to predict high-resolution velocity fields and wall shear stress on unstructured vascular meshes
- Designed physics-aware adaptive sampling weighted by velocity gradient magnitude, surface curvature, and wall proximity
- Proposed velocity-directed inlet detection for automatic rigid-body coordinate alignment between patient geometries, handling stenotic/diseased cases where magnitude-based methods fail
- Introduced wall-proximity-weighted loss to prioritize near-wall node accuracy critical for clinical wall shear stress estimation

Undergraduate Research Assistant

Shanghai Jiao Tong University — Apr 2019–Jun 2022

Combustion diagnostics and computational mechanics

- High-speed photography of turbulent flame dynamics with ML flame-front prediction reaching 89% accuracy (Center for Combustion and Environmental Technology, Prof. Lei Zhu)
- FEM analysis of ultrasonic wave propagation in composite materials during a 3-month research internship at LAUM, Le Mans Université (Prof. Vitali Goussev)

PUBLICATIONS

Journal Articles

[2026] **Xu, W.**, ... & McComb, C. (2026). Scalable super-resolution of flow conveyance systems through adaptive domain decomposition. *Journal of Computing and Information Science in Engineering*. DOI

[2026] **Xu, W.**, ... & Grande Gutiérrez, N. (2026). Energy-based feature extraction with adaptive local domain decomposition for prediction of transient and turbulence flow with operator regression models. *Computers & Fluids*. DOI

[2025] Chen, J., **Xu, W.**, ... & McComb, C. (2025). Enforcing the Principle of Locality for Physical Simulations with Neural Operators. *Journal of Computational Physics*. DOI

[2024] **Xu, W.**, McComb, C., & Grande Gutiérrez, N. (2024). Taylor series error correction network for super-resolution of discretized numerical solutions. *Journal of Computational Physics*. DOI

[2024] Chen, J., **Xu, W.**, Baldwin, M., Nijhuis, B., Boogaard, T. V. D., Gutiérrez, N. G., ... & McComb, C. (2024). Capturing Local Temperature Evolution during Additive Manufacturing through Fourier Neural Operators. *Journal of Manufacturing Science and Engineering*. ASME

Peer-reviewed Conference Proceedings

[2025] **Xu, W.**, ... & McComb, C. (2025). Fast super-resolution analysis of low-pressure duct air flow through adaptive domain decomposition. *IDETC-CIE 2025*. DOI

[2023] Chen, J., **Xu, W.**, et al. (2023). Capturing Local Temperature Evolution during Additive Manufacturing through Fourier Neural Operators. *IDETC-CIE 2023*. arXiv

[2023] **Xu, W.**, Grande Gutiérrez, N., & McComb, C. (2023). MegaFlow2D: A Parametric Dataset for Machine Learning Super-resolution in Computational Fluid Dynamics Simulations. In *Proceedings of CPS-IoT Week 2023*. *ACM*

Preprints

[2026] **Xu, W.**, Zhu, Y., Ge, C., ... & Gu, J. (2026). VeriPhy: Agentic Physical Reasoning for World Model Evaluation and Refinement. *arXiv preprint* | *project page*

[2026] Zhu, S., Zhu, Y., **Xu, W.**, Kuen, J., ... & Gu, J. (2026). Thinking with Anchors: Grounded and Efficient Document Reasoning. *arXiv preprint*

CONFERENCE & INVITED PRESENTATIONS

Conference Abstracts

Graph-Based Domain Decomposition for Scalable Cardiovascular Flow Super-Resolution
APS Division of Fluid Dynamics Meeting, Houston, TX
November 2025

Adaptive Local Domain Decomposition for Learning Large-Scale Multi-physics Numerical Simulations
APS Division of Fluid Dynamics Meeting, Salt Lake City, UT
November 2024

Taylor series error correction network for super-resolution of discretized fluid solutions
APS Division of Fluid Dynamics Meeting, Washington, DC
November 2023

MegaFlow2D: A Parametric Dataset for Machine Learning Super-resolution in Computational Fluid Dynamics Simulations.
CPS-IoT Week 2023, San Antonio, TX
May 2023

Invited Talks

Machine Learning for Large-Scale Multi-physics Engineering Simulations
CMU Mechanical Engineering Ph.D. Research Symposium
March 2025

Machine Learning in Large-Scale Engineering Simulations
Autodesk Research, San Francisco, CA
November 2024

TEACHING EXPERIENCE

24-261 Mechanics I (Undergraduate) • Ph.D. Teaching Assistant • Carnegie Mellon University
Fall 2024

24-718 Computational Fluid Dynamics (Graduate) • Ph.D. Teaching Assistant • Carnegie Mellon University
Fall 2023

Chassis and Powertrain Design (Undergraduate) • Teaching Assistant • Shanghai Jiao Tong University
Spring 2021

AWARDS & HONORS

Milton Shaw Ph.D. Research Award 2023
Graduate with Honors, SJTU 2022
Second Prize, Formula Student China 2022
Distinguished Conference Paper, SAECCE 2020 2020

PROFESSIONAL SERVICE

Memberships: Association for Computing Machinery (ACM) • American Society of Mechanical Engineers (ASME) • American Physical Society (APS) • American Heart Association (AHA)
Peer reviewer: IEEE/ASME Transactions on Mechatronics • Journal of Mechanical Design

TECHNICAL SKILLS

Computational Methods:
Development of custom numerical solvers for flow simulations • Finite element method (FEM) implementation • Computational fluid dynamics (CFD) • Turbulence modeling

Machine Learning:

Physics-informed neural networks (PINNs) • Graph neural networks (GNNs) • Neural operators • Vision–language models & agentic LLM systems • Diffusion-based video generation • Deep learning for scientific computing

High Performance Computing:
Parallel GPU programming • Experience with Bridges-2, TRACE, and multiple supercomputing clusters • Large-scale data processing • Distributed computing

Software & Tools:
Python, C++, MATLAB • PyTorch • FEniCS • MuJoCo • ANSYS, COMSOL Multiphysics • SolidWorks, CATIA • Git