Shuai Liu

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Computational Physicist & GPU Simulation Engineer

Ph.D. researcher with expertise in nonlinear fluid-structure interaction, high-performance multiphysics simulation, and control-oriented modeling. Experienced in C++/CUDA acceleration and open-source / in-house FEM/CFD frameworks. Passionate about physics-based simulation and robotics autonomy.

PROFESSIONAL SUMMARY

- Ph.D. candidate specializing in **physics-based simulation frameworks**, covering **fluid, solid, acoustic, and multiphysics dynamics** with applications in control and smart materials.
- Skilled in **CUDA programming** and GPU kernel optimization, as well as **hybrid parallel frameworks**.
- Experienced in **C++ numerical solver development** for multi-physics coupling systems.
- Passionate about leveraging computational mechanics expertise to enhance **robotics simulation platforms**.

EDUCATION

Shanghai Jiao Tong University, Mechanical Engineering,   *Ph.D. Candidate*   2022.9 – 2027.6
- Published 10 SCI papers (4 first-author) on multi-physics computation. National Scholarship Recipient.

Xi'an Jiaotong University, Mechanical Engineering,   *Bachelor of Engineering*   2018.9 – 2022.6
- Ranked top 5% in core courses: Advanced Mathematics, Linear Algebra, Parallel Computing, Control Theory.

TECHNICAL SKILLS

- **Programming:** C/C++ · CUDA · Python · PyTorch · MPI · OpenMP · Git · CMake · Linux
- **GPU/HPC:** GEMM Kernel Optimization · cuBLAS/cuBLASDx/cuSolver · Eigen/PETSc
- **Physics Simulation:** FEM/FVM/FDM · Physics-based Simulation · Multiphysics Coupling (Fluid, Structure, Acoustic, etc.) · Time Integration (explicit, implicit) · Nonlinear Solvers (Newton-Raphson)
- **Tools:** OpenFOAM · preCICE · ANSYS · COMSOL · NVIDIA's physics simulation frameworks (recently explored for traidtional (e.g. MuJoCo) and differentiable and GPU-based simulation (e.g. Newton).)

RESEARCH EXPERIENCE

J. Fluid Mech. (Top-tier in fluid mechanics) | *Multiphysics Simulation and RL-based control*   2025
- Developed a RL-based control framework that fuses flow-vibration information via PPO to modulate 3D plate-incompressible turbulence dynamics, accelerated on Xeon/V100 clusters. (*in progress, first-author*)

J. Fluid Mech. (Top-tier in fluid mechanics) | *Multiphysics Simulation*   2025
- Developed two-way strongly coupling ALE-FSI simulations of large-deformation piezoelectric beams in viscous flows with control, accelerated on Xeon/V100 clusters. (*published, first-author, doi:10.1017/jfm.2025.10556*)

Phys. Fluids (High-tier in fluid mechanics) | *Nonlinear Coupled-System Dynamics*   2025
- Conducted large-scale simulations and dynamic mode decomposition to uncover nonlinear coupling and control mechanisms in multiphysics oscillators. (*published, first-author, doi:10.1063/5.0256928*)

J. Sound Vib. (High-tier in dynamic simulation) | *Multiphysics Simulation*   2024
- Built and validated an FEM-FVM hybrid solver for fluid-structure-acoustic interactions, enabling DNS-scale vibration and vortex-lock-in analysis. (*published, first-author, doi:10.1016/j.jsv.2024.118643*)

INDUSTRY EXPERIENCE

Synopsys Inc., *GPU Computing Intern - Matrix Solver Optimization*   2025.7 – 2025.10
- Implemented and optimized **GPU-accelerated GEMM kernels** using shared-memory and register.
- Developed and optimized batched GEMM kernels based on cuBLASDx, implementing **multi-batch-on-one-block** and **two-stage pipelines** with shared memory tiling. An average speedup of **1.2x** and a maximum of **1.5x** under certain configurations are achievied.
- Integrated optimized kernels into in-house matrix solving (LU factorization) pipeline, yielding **1.3× average speedup** on production workloads. Resolved cross-platform synchronization deadlocks via cooperative groups and validated full test coverage across **H100/L40** clusters.