Xu Duan

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EDUCATION

The University of Texas at Austin Aug. 2024 - Dec 2025 (Expected)
Master of Science in Mechanical Engineering, Dynamic System and Control Area Austin, TX

- Co-Advised by Dr. Chen and Dr. van Oort
- Relevant Coursework: Learning-based Control, Stochastic Processes, Tensor Methods, Nonlinear Programming.

Shanghai Jiao Tong University Sep. 2019 - Jul. 2023
Bachelor of Engineering in Mechanical Engineering Shanghai, CN

- GPA: **3.79/4.3, 89/100**
- Advised by Dr. Fu
- Relevant Coursework: Modern Control, Digital Control, Finite Element Method, Computational Fluid Dynamics, Convex Optimization, Thinking and Approach of Programming, Data Structures

INDUSTRIAL EXPERIENCE

RAPID Aug. 2024 - Present
Well Hydraulics and Control Research Assistant, Supervisor: Dr. van Oort Austin, TX

- Developed a two-phase fluid model to analyze well hydraulics and thermodynamics in MATLAB, using the Finite Volume Method (FVM) to predict pressure profile, flow rates, and temperature, with validation against experimental data.
- Implemented a blowout risk mitigation plan with bottomhole pressure and temperature control.
- Developed a Model Predictive Controller (MPC) for bottomhole pressure and temperature control.

State Key Laboratory of Ocean Engineering Sep. 2023 - Jun. 2024
Ocean Engineering Research Assistant, Supervisor: Dr. Fu Shanghai, CN

- Developed a Fortran program to numerically solve fully nonlinear Boussinesq Wave Model from scratch.
- Applied the Monotonic Upstream-centered Scheme for Conservation Law (MUSCL) for spatial discretizing and utilized the third-order Strong Stability-Preserving (SSP) Runge-Kutta scheme for time integration.

ACADEMIC EXPERIENCE

Shanghai Jiao Tong University Sep. 2023 - Jan. 2024
Teaching Assistant for Junior-level Structural Dynamics Shanghai, CN

- Guided junior students in learning Abaqus and constructing a basic ship model to do modal analysis.
- Taught students how to apply the FEM to develop a program to solve non-homogeneous beam bending problems.

SELECTED PROJECTS

Trajectory-Optimized Density Control with Flow Matching **https://arxiv.org/abs/2510.06666**

- Developed a novel trajectory-optimized flow-matching framework that integrates optimal transport (OT) and Schrödinger bridge (SB) principles for multi-agent density control.
- Formulated transport as a path-dependent optimization problem, enabling explicit handling of collision avoidance and other trajectory-based constraints.
- Unified mean-field control and flow-based generative modeling, providing a principled approach to coordinated multi-agent motion planning.
- Demonstrated that the proposed method achieves collision-free transport while maintaining computational efficiency comparable to standard flow-matching algorithms.

Model Predictive Controller (MPC) for Geothermal Well for National Oilwell Varco (NOV) **Paper**

- Developed a physics-based pressure–temperature control framework integrating RDFM, thermodynamics, and proactive algorithms.
- Applied SINDy to build reduced-order models capturing key drilling dynamics.
- Designed an MPC system to jointly regulate BHP and BHCT, ensuring stability in HPHT and geothermal conditions.

Sequential Quadratic Programming Iterative Learning Control for a Roll2Roll Manufacturing Process **Paper**

- Developed an SQP-based Iterative Learning Control (ILC) framework for nonlinear R2R dry transfer systems.

- Addressed nonlinear peeling dynamics and input constraints to enhance transfer precision.
- Validated experimentally on a graphene transfer testbed, achieving improved quality with minimal computation.

Hydraulic Forces Induced by Drillstring Whirling and Rotation Dynamics: A Numerical Investigation **Paper**

- Conducted CFD simulations using the Finite Volume Method (FVM) to quantify hydraulic forces on whirling drillstrings.
- Modeled coupled lateral–torsional motions with dynamic mesh for accurate fluid–structure interaction.
- Analyzed effects of rotation, whirling frequency, and fluid rheology in 2D and 3D domains to improve drilling performance understanding.

Control System Design for an Underwater Vehicle

- Developed a Simulink model for simulating an underwater vehicle, incorporating a 4-DOF dynamic model of the ROV, along with a propulsion system model and a voltage allocation module.
- Designed a Proportional Integral Differential (PID) control system to correct deviations between the robot's actual depth and heading, achieving 18.50% and 31.57% overshoot, with settling time of 5.13s and 12.84s for depth and heading, respectively.

Solving Linear Advection Equation using Streamline-Upwind Petrov-Galerkin (SUPG) Method

- Solved the linear advection equation with adaptive mesh refinement using deal.II on a Linux system.
- Utilized parallel computing with multiple processors accessing shared memory techniques in deal.II to assemble the global matrix and accelerate computation.

PUBLICATIONS

- **Duan, X.**, & Chen, D. (2025). Trajectory-Optimized Density Control with Flow Matching. arXiv preprint. http://arxiv.org/abs/2510.06666
- ***Duan, X.**, Chen, D., Li, W. (2025). Stochastic Iterative Learning Control for a Roll-to-Roll Manufacturing. (under review)*
- ***Duan, X.**, Zhang, Y., Ashok, P., Chen, D., & van Oort, E. (2025). Integration of MPD with Managed Temperature Drilling (MTD) for Geothermal and HPHT Drilling. SPE/IADC Managed Pressure Drilling and Underbalanced Operations Conference and Exhibition.* https://doi.org/10.2118/SPE-228390-MS
- ***Duan, X.**, Zhang, Y., Ashok, P., Chen, D., & van Oort, E. (2025). Hydraulic Forces Induced by Drillstring Whirling and Rotation Dynamics: A Numerical Investigation in 2D and 3D Domains. 44th International Conference on Ocean, Offshore & Arctic Engineering (OMAE).* https://doi.org/10.1115/OMAE2025-156410
- ***Duan, X.**, Zhang, Y., Ashok, P., Chen, D., & van Oort, E. (2025). Coupled Managed Pressure and Temperature Drilling in Geothermal and HPHT Wells. 50th Stanford Geothermal Workshop.*

HONORS & AWARDS

Philip C. and Linda L. Lewis Foundation Graduate Fellowship	Aug. 2024
China National Scholarship	Sep. 2022 & Sep. 2020
Shengshen Scholarship (5%)	Sep. 2020

SKILLS AND QUALIFICATIONS

Programming: Python, C/C++, Linux, MATLAB
IELTS: 7.0 (Listening: 7.5, Reading 8.0, Writing: 7.0, Speaking: 6.0)
GRE: 336+4.0 (Verbal: 166, Quantitative: 170, Analytical Writing: 4.0)

Transferable Attributes:

- Superior diagnostic skills for issues and innovative invention practices;
- Capacity to coordinate and optimize solutions and conduct flexible commissioning;
- Collaborative teamwork skills;
- Foresight and vision to evaluate the complexity of projects.