Haonan Fan, Ph.D.

fan.hao@northeastern.edu | (781) 333-1809 | Boston, MA | linkedin.com/in/h-fan/

Summary

Robotics and control engineer with Ph.D. training and postdoctoral experience in motion control, dynamic system modeling, embedded firmware development, wearable robotics, and servo tuning. Proven track record of taking robotic systems from concept through hardware implementation and experimental validation, including actuator design and real-time control. Specialized in motion control for robotic systems, with hands-on experience in mechanical design, cable-driven actuators, motor drivers, embedded systems, and physics-informed machine learning for data-efficient algorithm development.

Technical Skills

Control & Robotics:	Motion control, servo tuning, PID control, mathematical modeling, dynamic system modeling, robot dynamics, multi-agent system, filter design, state estimation, system identification
Programming & Simulation:	Python, C++, MATLAB, Simulink, Simscape
Hardware & Embedded Systems:	BLDC motors, field-oriented control (FOC), motor drivers, CAN-based communication, DAQ systems, sensors, firmware, cable-driven actuators, microcontrollers, electrical system design, digital circuit design, analog circuit design, lab skills
Machine Learning:	Pytorch, TensorFlow, Physics-informed neural networks (PINN), CNNs, TCN
Mechanical Modeling:	SolidWorks, AutoCAD

Professional Experience

Postdoctoral Research Associate

Northeastern University, Shepherd Lab | Boston, MA **Jan 2025 — Present**

- Owned system-level integration across mechanical design, sensing, actuation, control, and data analysis.
- Developed and maintained control pipelines, including firmware-level sensor integration and rea-time control execution.
- Designed and supervised human-subject and benchtop experiments, ensuring safety, repeatability, and data quality.
- Led ankle exoskeleton system design, implementation, and experimental validation of wearable robotic systems.
- Mentored 3 graduate students in system design, experimentation, and data-driven modeling.
- Prepared 1 peer-reviewed manuscript and contributed to 2 research grant proposals.

Graduate Researcher

Northeastern University, Department of Mechanical & Industrial Engineering | Boston, MA **Jan 2019 — Dec 2024**

- Conducted independent doctoral research on control of robotic and electromechanical systems over 5 years.
- Developed analytical, numerical, and experimental methods for control design.
- Implemented simulations and hardware-in-the-loop (HIL) tests for control validation.
- Led robotics and control projects from problem formulation to experimental validation and publication.
- Authored 4 peer-reviewed journal and 2 conference publications and received the best paper award.

Selected Projects

Postdoctoral Project: Exoskeleton Systems Development and Human Joint Torque Estimation

Goal: Create a compact, lightweight, and cost-effective ankle exoskeleton platform, and develop data-efficient human joint torque estimation strategies.

- Achieved ~90% reduction in required training data for human joint torque estimation using a PINN.
- Designed and optimized ankle exoskeleton linkage mechanisms, resulting in an overall frontal dimension < 15 cm.
- Modified brushless motor driver firmware to directly acquire IMU data, eliminating the need for external data hubs.
- Conducted experimental studies with machine-learning-based control strategies using a Dephy ankle exoskeleton.
- Integrated control algorithms into the lab's exoskeleton software codebase.

Postdoctoral Project: Cable-Driven Actuator Design and Development

Goal: Develop a unidirectional cable-driven actuator that eliminates cable slack and enables fast, stable force control for exoskeletons and human-subject experiments.

- Developed mathematical models for cable routing and programmable stiffness spring mechanisms.
- Designed, implemented and experimentally validated the actuator for robotic and human-interaction applications,
- Achieved force control with settling time < 0.1 s in benchtop experiments.
- Collaborated with a neuroscience research team on a pilot study of human motor control and learning using the actuator.
- Prepared and submitted a peer-reviewed journal manuscript.

Ph.D. Project: Control of Multi-Robot Systems with Time Delays

Goal: Develop control strategies and tools for multi-robot systems with time delays for fast consensus control.

- Developed delay-based control methods (IR and PR controllers) for robotic and electromechanical systems

- Implemented numerical and graphical tuning methodologies for delayed systems
- Proposed state estimation observer for systems with delays, and improved the regression speed by ~20%
- Analyzed and improved stability and transient performance of large-scale multi-robot systems with more than 100 robots
- Developed MATLAB-based tools for delay margin computation and performance evaluation
- Results published in 4 impactful journals and presented in 4 leading international conferences

Ph.D. Project: Robotic Arm Motion Control

Goal: Repurpose a haptic device into a 3-DOF robotic arm for teaching purposes.

- Designed and planned a 3-DOF robot trajectory with forward and inverse kinematics for the end-effector and actuators and simulated the motion control in Simulink/Simscape with SolidWorks model
- Implemented PID and PI controllers with IIR filters with experimental validation using a Phantom Omni haptic device

Education

Northeastern University, Boston, MA **Dec 2024**
Ph.D. in Mechanical Engineering, Concentration in Mechatronics
Dissertation: *"Robotic Consensus Problem with Multiple Delays: Improvements using Delay-based Controllers"*

Northeastern University, Boston, MA **Aug 2019**
M.S. in Mechanical Engineering, Concentration in Mechatronics

South China University of Technology, Guangzhou, China **July 2017**
B.S. in Mechatronic Engineering

Teaching Experience

Part-Time Lecturer
Northeastern University | Boston, MA **Jan 2025 — May 2025**

- ME5245: Mechatronics Engineering, covering system modeling, electronics, sensing, actuation, and control

Teaching Assistant
Northeastern University, Department of Mechanical & Industrial Engineering | Boston, MA **Sep 2019 — Dec 2024**

- Taught and supported over 800 students across 7 courses and 20 semesters in robotics, control, and mechatronics

Selected Publications

(2026, under review) D. Gupta, H. Fan, and M. Shepherd, "A Cable-Driven Actuator with Programmable Elasticity for Dynamic Slack Regulation"

(2024) A. Martínez-González, H. Fan, R. Sipahi and A. Ramírez, "Design Guidelines to Accelerate Consensus Using Intentional Delays in a Multiagent System Over Mixed Graphs," in IEEE Control Systems Letters, Impact Factor: 3

(2024) H. Fan, A. Ramírez, S. Mondié, and R. Sipahi, "Direct Current Motor Velocity Control with Integral Retarded Controller Under Unintentional Delay" in ASME Journal of Computational and Nonlinear Dynamics, Impact Factor: 2.1

(2023) H. Fan, A. Ramírez, S. Mondié, and R. Sipahi, "Proportional-Retarded Controller Design for Single-Integrator Dynamics Against Unintentional Delays" in IEEE Control Systems Letters, Impact Factor: 3

(2022) H. Fan, A. Ramírez, and R. Sipahi, "Consensus Stability of a Large-Scale Robotic Network Under Input and Transmission Delays" in IEEE Transactions on Control of Network Systems, Impact Factor: 4.2

Selected Awards

Yamamura Research Award, Northeastern University **Apr 2024**
Best Paper Award, 19th MSNDC, ASME IDETC-CIE **Aug 2023**
Ferretti Teaching Award, Northeastern University **Apr 2023**
John and Katharine Cipolla PhD Merit Award, Northeastern University **Nov 2021**