Max Muchen Sun

☎ 773-313-5186 | ✉ msun@u.northwestern.edu | 🔗 LinkedIn | ⌘ GitHub | 🌐 Portfolio | 🎓 Google Scholar

EDUCATION

Northwestern University   Evanston, IL
Ph.D. in Mechanical Engineering (Robotics Specialization)   *Jan 2021 − Aug 2025 (Expected)*
M.Sc. in Mechanical Engineering (Robotics Specialization)   *Sep 2019 − Jan 2021*
Certificate in Research Communication   *Aug 2021*

Kellogg School of Management - Northwestern University   Evanston, IL
Certificate in Management for Scientists and Engineers   *Aug 2023*

Lanzhou University   Lanzhou, China
B.Sc. in Computer Science   *Sep 2015 − Jun 2019*

EXPERIENCE

Researcher | Northwestern University / Honda Research Institute   *June 2020 − Present*
Advisors: Prof. Todd Murphey, Dr. Peter Trautman

- Full-stack development (perception, prediction, planning, design) of a human-aware robot navigation system in dense crowds using game theory and with onboard perception and computation.
- Developed algorithms to jointly predict human intent and plan robot paths under behavioral uncertainty, ensuring formal optimality guarantees using game theory. Conducted benchmark studies on real-world human datasets.
- Implemented and tested generative human intent and trajectory prediction models using Gaussian processes, recurrent neural networks, and variational autoencoders.
- Deployed the algorithm on a customized wheeled robot for large-scale real-world experiments in Santa Cruz, CA.
- Deployed a vectorized PyTorch implementation of the algorithm on an Nvidia Jetson AGX Orin and a Unitree Go1 quadruped for ongoing research on runtime learning of human internal states.
- Co-wrote the white paper for the joint grant. Present at internal seminars. Prepare presentation slides and assist the project manager on the annual project report.

Graduate Researcher | Northwestern University   *Sep 2019 − Present*
Advisor: Prof. Todd Murphey

- Study active learning methods for embodied agents, with a focus on exploration in uncertain environments.
- Derived a scalable ergodic exploration algorithm for Lie groups and high-dimensional space using kernel functions. Implemented the algorithm in C++ for robot learning from human demonstrations.
- Developed a robust point cloud registration algorithm by constructing continuous volumetric fields through Fourier decomposition. Implemented the algorithm in C++ for real-time 3D object tracking with CAD models.
- Developed and prototyped a tree-search algorithm for fast on-board locomotion learning on a soft robot.
- Mentor 1-2 undergraduate or graduate students yearly. Maintain the lab server and the lab website.

Lecturer & Teaching Assistant | Northwestern University   *Fall 2020, Spring 2023, Spring 2024*

- Participated in the curriculum and lecture design for "ME455: Active Learning for Robotics", contents including Bayes filters, Monte Carlo methods, and generative models (Gaussian-mixture models, variational autoencoders).
- Gave lectures, created and graded homework assignments, and held office hours for "ME314: Machine Dynamics" and "ME455: Active Learning for Robotics".

PUBLICATIONS [GOOGLE SCHOLAR]

[1] **M. Sun**, P. Trautman, and T. Murphey. "Inverse Mixed Strategy Games with Generative Trajectory Models." *(Conference submission under review)*, 2024.

[2] **M. Sun**, A. Gaggar, P. Trautman, and T. Murphey. "Fast Ergodic Search with Kernel Functions." *(Journal submission under review)*, 2024. [arXiv]

[3] **M. Sun**, F. Baldini, K. Hughes, P. Trautman, and T. Murphey. "Mixed Strategy Nash Equilibrium for Crowd Navigation." *International Journal of Robotics Research (IJRR)*, 2024. [Website | arXiv]

[4] J. Ketchum, S. Schiffer, **M. Sun**, P. Kaarthik, R. Truby, and T. Murphey. "Automated Gait Generation For Walking, Soft Robotic Quadrupeds." In *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. Detriot, MI, USA, 2023. [arXiv]

[5] **M. Sun**, A. Pinosky, I. Abraham, and T. Murphey. "Scale-Invariant Fast Functional Registration." In *The International Symposium of Robotics Research (ISRR)*. Geneva, Switzerland, 2022. [Website | arXiv | Code]

[6] **M. Sun**, P. Trautman, and T. Murphey. "Human-Robot Pacing Mismatch." In *RSS Workshop in Close-Proximity Human-Robot Collaboration.* New York City, NY, USA, 2022. [arXiv]

[7] **M. Sun**, F. Baldini, P. Trautman, and T. Murphey. "Move Beyond Trajectories: Distribution Space Coupling for Crowd Navigation." In *Robotics: Science and Systems (RSS)*. Virtual, 2021. [arXiv | Code | Video]

Awards & Achievements

Martin Outstanding Doctoral Fellowship Awarded to mid-career Ph.D. candidates for outstanding scholar and research achievements in mechanical engineering by Northwestern University. (2022)

Service & Leadership

Reviewer | Peer-Reviewed Academic Journals and Conferences *2021 − Present*
- IJRR, T-RO, RA-L, IROS, ICRA, RO-MAN, ITSC

Volunteer Museum Presenter | Chicago's Museum of Science and Industry *2022 − Present*
- Presented current robotics research projects to the public during national robotics week.

Volunteer Lab Tour Presenter | Career Day for Girls at Northwestern University *2022 − Present*
- Presented current robotics research projects to middle school and high school students from the Chicagoland area.

Student Administrator | Center of Robotics and Biosystems, Northwestern University *2021 − 2022*
- Organized monthly meetings and communicated between faculty and students on administrative affairs.

Chair of Career Development | ME Graduate Student Society, Northwestern University *2021 − 2022*
- Organized the monthly alumni talk to discuss career development with current graduate students.
- Communicated graduate student feedback with the department and the advisory board.

Selected Talks

Hands-on Introduction to Ergodic Control [Website] Yokohama, Japan
Tutorial on Ergodic Control at ICRA 2024 *May 2024*

Social Crowd Navigation with NVIDIA Jetson [Recording] San Jose, CA
NVIDIA GTC, Jetson Community Projects Showcase (Co-Presenter) *March 2024*

Reasoning Over Flexibility for Social Navigation [Recording] New York City, NY
Workshop of Close-Proximity Human-Robot Collaboration, Robotics: Science and Systems (RSS) *July 2022*

Distribution Space Coupling for Crowd Navigation [Recording] Virtual
Robotics: Science and Systems (RSS) Spotlight Talk *June 2021*

Patents

[1] **M. Sun**, F. Baldini, P. Trautman, and T. Murphey. "Game-Theoretic Path Planning for Social Navigation." (Provisional Patent Filed). Serial Number: 18/316856. 2023.

Open Source Software

BRNE [GitHub] Human-aware navigation with mixed strategy Nash equilibrium (PyTorch, C++, NVIDIA Jetson)
DistNav [GitHub] Toolbox for Game-Theoretic Distribution Space Crowd Navigation (Numba, JAX)
FLS [GitHub | Demos] Functional Least-Squares Optimization for Point Cloud Registration (C++, OpenMP, Ceres)
Ergodic Control Sandbox [GitHub] Sandbox Code for "Tutorial on Ergodic Control" at ICRA 2024 (JAX)

Skills

Programming: Python (NumPy, Matplotlib, JAX, PyTorch, Numba), C++ (Eigen, Sophus, OpenMP, Ceres, PCL)

Software: Linux, Robot Operating System (ROS), Vim, LaTeX, Adobe Premiere Pro, Adobe Illustrator

Mentoring

- Maia Traub (B.S. student in mechanical engineering, currently at Universal Creative) *2024*
- Srikanth Schelbert (M.S. student in robotics, currently at Carnegie Mellon University) *2024*
- Katie Hughes (M.S. student in robotics, currently at Boston Dynamics AI Institute) *2023*
- Tommy Li (B.S. student in mechanical engineering, currently at University of Pennsylvania) *2023*
- Meg Sindelar (M.S. student in robotics, currently at Applied Research Associates, Inc.) *2023*
- Sophia Schiffer (B.S. student in mechanical engineering) *2023*
- Bowen Feng (M.S. student in robotics, currently a Ph.D. student at Princeton University) *2022*
- Tianyu Li (M.S. student in robotics, currently a Ph.D. student at the University of Pennsylvania) *2022*