Nan Wang

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EDUCATION

University of California, Santa Cruz, *Santa Cruz, CA* *Sep 2018—Aug 2024*
Ph.D. in Computer Sci. and Eng., **GPA:** 3.85/4.0,
Emphasis: motion planning, model predictive control, constrained control, hybrid systems.

Tongji University, *Shanghai, China* *Sep 2015—Jun 2018*
M.S. in Control Sci. and Eng., **GPA:** 4.33/5.0, **Emphasis:** trajectory planning, autonomous driving.

East China Univ. of Sci. and Tech., *Shanghai, China* *Sep 2011—Jun 2015*
B.E. in Automation, **GPA:** 3.50/4.0, **Emphasis:** path planning.

TECHNICAL SKILLS

Specialized Skills: dexterous manipulation, reinforcement learning, simulation, sim-to-real transfer, motion planning, control systems, robot perception, SLAM, numerical optimization.
Programming Languages: C/C++, Python.
Frameworks & Tools: ROS2, MuJoCo, PyTorch, OpenCV, ORB-SLAM3, OMPL, Gurobi, Git, MATLAB/Simulink.

PROFESSIONAL EXPERIENCE

Chestnut Robotics (formerly TetherIA AI), *Santa Clara, CA* *May 2025 - Now*
Founding Robotics Engineer

- Independently led the development of the company's sim-to-real Reinforcement Learning pipeline for the tendon-driven Aero Hand Open, enabling zero-shot policy deployment on real hardware.
  - Built a high-fidelity MuJoCo/MJX simulation of the tendon-driven hand with a fully modeled tendon transmission system, enabling underactuated control where a single tendon drives multiple joints rather than independent joint actuation.
  - Developed a reinforcement learning environment for dexterous cube manipulation with Z-axis rotation; the environment was merged into DeepMind MuJoCo Playground official repository as an example task.
  - Achieved sim-to-real zero-shot transfer by calibrating the mapping between MuJoCo tendon actuation signals and real Aero Hand Open motor commands, enabling policies trained in simulation to run directly on hardware.
- Built a precision grasping system using FoundationPose and Segment Anything Model 3 (SAM3), achieving $\geq 90\%$ grasp success rate on single-object grasp tasks.
- Led development of the wrist-tracking SLAM/VIO system for DexUMI using industrial cameras and IMUs, including multi-sensor calibration, synchronization, and data infrastructure; collaborated with teammates on perception, data synthesis, and policy efforts involving video segmentation, video inpainting, diffusion-based policies, and VLA-related experimentation.
- Designed and implemented a real-time ROS2 teleoperation system using GELLO, Vive Trackers, and Manus Gloves.
- Leading initial development of Meta Quest-based teleoperation for a wheeled humanoid robot, using Mink IK to map human motion targets to real-time arm commands. Also prototyping a SLAM-assisted grasping workflow that integrates scene perception with scripted grasp sequences for real-robot object manipulation experiments.

Hybrid Systems Laboratory, *Santa Cruz, CA* *Sep 2018 - May 2025*
Post-Doctoral Researcher & Graduate Student Researcher, **PI:** Ricardo Sanfelice
Dissertation: *Provably Correct and Efficient Motion Planning for Hybrid Dynamical Systems*[1]-[4].

- Designed sampling-based motion planning algorithms integrating hybrid system techniques for robotics applications.
- Focused on contact-rich environments, demonstrated on bipedal robots and collision-resilient drones.
- Established probabilistic completeness and asymptotically near-optimality of the proposed algorithms.
- Developed and implemented MPC tracking methods for hybrid systems, ensuring stability and solving mixed-integer nonlinear programming with numerical optimization tools like OPTI, Matlab/GA, and Gurobi.

Mitsubishi Electric Research Laboratories, *Cambridge, MA* *Feb 2023 - April 2023*
Research Intern, **Host:** Stefano Di Cairano
Project: *Switched Reference Governor for Control Systems* [5].

- Designed a general switched reference governor (RG) framework for constraint and safe control, switching between a fast, oscillating RG and a slow, non-oscillating RG to achieve fast and non-oscillating convergence while ensuring constraint satisfaction.
- Established recursive feasibility and strong robustness of the switching mechanism to maintain safety guarantees.

Open-Source Contributions:

- **MuJoCo Menagerie (Google DeepMind)** Developed and integrated tendon-driven dexterous hand models into the official repository, enabling reproducible research for robotic manipulation and used by academic and industry researchers worldwide.
- **MuJoCo Playground** Implemented dexterous manipulation environments, RL training modules, and simulation tooling widely used for benchmarking reinforcement learning algorithms.
- **Open Motion Planning Library (OMPL)** Added the HyRRT and HySST algorithms into OMPL, one of the most widely used open-source motion-planning frameworks in robotics research. The integration provides the global robotics community with accessible implementations of hybrid-systems motion planners, supporting reproducible research and enabling researchers to benchmark and evaluate hybrid planning algorithms within a standard, widely adopted platform.

Student Supervision:

- Shreya Baronia and Tharuka Kodituwakku, *Autonomous underwater ROV Path Planning for Ocean Floor Scanning (in collaboration with Monterey Bay Aquarium Research Institute).*
- Akhil Datla, *Path Planning for Multi-Agent Autonomous Aircraft for Wildfire Monitoring.*
- Beverly Xu, *C++ Implementation of Sampling-based Motion Planning Algorithms for Hybrid Systems* [7].
- Adam Ames, *A Set-based Motion Planning Algorithm for Aerial Vehicles in the Presence of Obstacles Exhibiting Hybrid Dynamics* [8].

SELECTED RESEARCH PROJECTS

Sampling-based Motion Planning:

- RRT-Connect Fast Planning for Hybrid Systems [4] June 2023 - Jan 2024
  - Achieved an average 77.0% improvement in computational time and an 80.1% reduction in vertex creation using bidirectional propagation compared to the standard RRT algorithm, demonstrated on bipedal robots.
- SST Optimal Planning for Hybrid Systems [3] Dec 2022 - Mar 2023
  - Improved computational performance by 82.1% in computation time and 77.0% in vertex creation through vertex sparsification, with proven asymptotic near-optimality compared to the standard RRT algorithm, demonstrated on collision-resilient aerial vehicles.
- RRT Feasible Planning for Hybrid Systems [2] Sep 2021 - Mar 2022

- Designed and implemented an RRT-based algorithm specifically for hybrid systems, achieving a 95.5% enhancement in computational performance, with proven probabilistic completeness.
- Integrated the algorithm into the Open Motion Planning Library (OMPL). The implementation in C++ achieved an average real-time performance of 251 ms in solving a 6-dimensional motion planning problem for a walking robot system, compared to over 54.7 seconds using MATLAB.

• Foundation Theory on Motion Planning for Hybrid Systems [1] Sep 2018 - Mar 2021
- Formulated a motion planning problem using a hybrid equation framework, providing the convenience of reasoning most motion planning tasks under different specifications and complex dynamics constraints within the unified problem data.

Control Theory:

• Model Predictive Tracking Control for Hybrid Systems Sep 2023 - Dec 2024
- Developed breakthrough design methods for model predictive control (MPC) to track motion plans for hybrid systems by recasting the tracking problem into a set-stabilization problem, with proven stability.
- Implemented the hybrid MPC algorithm by solving the mixed-integer nonlinear programming using numerical optimization tools such as OPTI, Matlab/GA, and Gurobi.

Robotics and Autonomous Driving Applications:

• Path-following Control for Car-like Robots [6] Sep 2021 - Jul 2023
- Designed a local path-invariant controller ensuring convergence to and invariance of the path by defining a"tight" obstacle-free neighborhood and employing control Lyapunov and control barrier functions.
- Integrated within a unified hybrid framework, it switches between a local path-invariant controller and a global tracking controller, guaranteeing global convergence and robustness to sensor noise.

• Planning in Hybrid Uncertain Environment for Drones [8] Sep 2021 - Jan 2022
- Designed a planning algorithm that, by comparing reachable sets and predicting unsafe sets through hybrid dynamics simulation considering uncertainty, identifies a set of safe motion primitives.

• Decision Making, Planning and Control for Autonomous Vehicles Jan 2018 - Aug 2018
- Led a team in developing decision-making, planning, and control modules for autonomous vehicles. Utilized Stateflow for a finite state machine-based decision-making module.

• Flow Field-guided Planning for Autonomous Vehicles [9]-[11] Mar 2017 - Jul 2018
- Created a novel trajectory planning algorithm leveraging fluid-flow field information for smooth navigation.
- Incorporated reasoning of traffic scenarios from a Computational Fluid Dynamics (CFD) perspective.

• Planning for Autonomous Parking Systems Jul 2015 - Dec 2015
- Devised a geometric path-planning method for autonomous parking systems, reducing the minimal length of feasible parking spaces by 7%.

ADDITIONAL INFORMATION

Award: Cyber-physical Systems Research Center 2025 Best Dissertation Award, Chancellor's Fellowship.

Teaching Assistantship: Analysis of Algorithm, Database Systems, Robot Automation, Computer Systems and C Programming.

Academic Service: Member of Technical Committee on Hybrid Systems in IEEE Control System Society

SELECTED PUBLICATIONS

[1] **N. Wang**, and R. Sanfelice, Motion Planning for Hybrid Dynamical Systems: Framework, Algorithm Template, and a Sampling-based Approach, The International Journal of Robotics Research (IJRR), 2025.**[Link]**

[2] **N. Wang**, and R. Sanfelice, A Rapidly-Exploring Random Trees Motion Planning Algorithm for Hybrid Dynamical Systems, in the 61st IEEE Conference on Decision and Control, 2022. [**Link**]

[3] **N. Wang**, and R. Sanfelice, HySST: An Optimal Motion Planning Algorithm for Hybrid Dynamical Systems, in the 62nd IEEE Conference on Decision and Control, 2023. [**Link**]

[4] **N. Wang** and R. Sanfelice, HyRRT-Connect: A Bidirectional Rapidly-Exploring Random Trees Motion Planning Algorithm for Hybrid Systems, in the 8th IFAC Conference on Analysis and Design of Hybrid Systems, 2024.[**Link**]

[5] **N. Wang**, S. Di Cairano and R. Sanfelice, A Switched Reference Governor for High Performance Trajectory Tracking Control under State and Input Constraint, 2024 American Control Conference.[**Link**]

[6] **N. Wang**, A. Akhtar, R. Sanfelice. A Safe Hybrid Control Framework for Car-like Robot with Guaranteed Global Path-Invariance using Control Barrier Function, submitted to the 9th IEEE Conference on Control Technology and Applications (CCTA), 2025. [**Link**]

[7] B. Xu, **N. Wang**, and R. Sanfelice, cHyRRT and cHySST: Two motion planning tools for hybrid dynamical systems, 2025 IEEE 21st International Conference on Automation Science and Engineering (CASE). IEEE, 2025. [**Link**]

[8] A. Ames, **N. Wang**, and R. Sanfelice, A Set-based Motion Planning Algorithm for Aerial Vehicles in the Presence of Obstacles Exhibiting Hybrid Dynamics, in the 6th Conference on Control Technology and Applications, 2022. [**Link**]

[9] **N. Wang**, M. Song, J. Wang, and T. Gordon, A Flow-field Guided Method of Path Planning for Unmanned Ground Vehicles, in the 56th IEEE Conference on Decision and Control, 2017, pp. 2762-2767. [**Link**]

[10] M. Song, **N. Wang**, T. Gordon, and J. Wang, Flow-field Guided Steering Control for Rigid Autonomous Ground Vehicles in Low-speed Manoeuvring, Vehicle system dynamics, vol. 57, no. 8, pp. 1090-1107, 2019. [**Link**]

[11] M. Song, **N. Wang**, J. Wang, and T. Gordon, A Fluid Dynamics Approach to Motion Control for Rigid Autonomous Ground Vehicles, in the 25th International Symposium on Dynamics of Vehicles on Roads and Tracks (IAVSD 2017), 2021, p. 347. [**Link**]