Bohao Zhang

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EDUCATION

University of Michigan | Ph.D. Candidate in Robotics | GPA 3.77/4.00
Sep 2020 - April 2025 (anticipated) • Ann Arbor, MI

- *Coursework:* Robot Kinematics & Dynamics, Nonlinear Systems, Motion Planning, Applied CUDA Programming, Machine Learning

University of Michigan | B.S. in Computer Engineering | Minor in Mathematics | GPA 3.76/4.00
Sep 2018 - Aug 2020 • Ann Arbor, MI

Shanghai Jiaotong University | B.S. in Electronic & Computer Engineering
Sep 2016 - Aug 2020 • Shanghai, China

TECHNICAL SKILLS

Programming Languages: C/C++ • CUDA • cmake • Python • Matlab
Softwares: Eigen • pinocchio • IPOPT • MuJoCo • PyBullet • git • PyTorch • docker • ROS2
Robotic Platforms: Digit-v3 (humanoid) • Kinova-Gen3 (manipulator) • Cassie (bipedal robot) • 2 Wheel Segway

PROFESSIONAL EXPERIENCE

Anyware Robotics | Robotics Intern
Feb 2024 - May 2024 • Fremont, CA

- Designed optimization-based motion planning algorithms in C++ for mobile-base manipulators to facilitate truck loading and unloading tasks.
- Engaged in high-pace development and debugging workflow in a start-up environment.
- Deployed at customer's warehouse for data collection and algorithm development.

RESEARCH EXPERIENCE

Rapid Offline Gait Optimization For Humanoids | University of Michigan
May 2022 - Sep 2024 • Ann Arbor, MI

- Developed an optimization algorithm to generate a library of physically feasible while energy efficient multiple-step gaits including different step lengths and step heights.
- Parameterized walking gaits as Bezier curves to generate smooth trajectories.
- Efficiently handled closed-loop linkage on humanoids' ankles for controlling the orientation of the feet as differentiable kinematics constraints for faster optimization.
- Implemented the algorithm fully in C++ that outperforms related works in terms of computation time and gait energy consumption.

Provably-safe Real-time Trajectory Optimization For Robotic Manipulators | University of Michigan
May 2022 - May 2024 • Ann Arbor, MI

- Developed a real-time optimization algorithm to generate provably safe trajectories, incorporating controller tracking errors.
- Enforced safety over continuous time intervals instead of discrete time instances for collision avoidance, robot torque limits, and gripper contact forces.
- Optimized constraint evaluation via parallel computation to significantly reduce computation time.
- Achieved higher collision avoidance success rates compared to existing methods.

Robust Control For Humanoids and Robotic Manipulators | University of Michigan
May 2022 - Aug 2024 • Ann Arbor, MI

- Developed a model-based robust controller that provides guaranteed uniform tracking error bound in presence of bounded robot model uncertainty.
- Construct the tracking error bound by constraining the upper bound of a Lyapunov function.
- Incorporated closed-loop linkage dynamics on humanoids' ankles as kinematics constraints into the controller for better tracking performance on humanoids.

System Identification For Humanoids and Robotic Manipulators | University of Michigan

Sep 2023 - Aug 2024 • Ann Arbor, MI

- Developed a general optimization-based system identification algorithm for both humanoids and robotic manipulators to estimate robot inertial parameters and motor friction parameters.
- Provided bounds on estimation of the robot model parameters based on the Cramér–Rao bound to integrate it into the robust controller for guaranteed tracking performance.
- Implemented the whole pipeline in C++ for faster computation time.

Safe, Optimal, Real-time Trajectory Planning For Autonomous Vehicles | University of Michigan
Mar 2019 - May 2020 • Ann Arbor, MI

- Solved a sum-of-squares polynomial formulation of the trajectory optimization problems for collision avoidance between obstacle point cloud and vehicle reachable sets.
- Applied the parallel Bernstein algorithm to find the global optimum of the constrained optimization problem to minimize trajectory length while avoiding obstacles.
- Designed and implemented algorithms in C++/CUDA for online real-time planning.

PUBLICATIONS

- [**CoRL'24 Workshop**] Yongseok Kwon, Jonathan Michaux, Seth Isaacson, **Bohao Zhang,** Matthew Ejakov, Katherine A. Skinner, Ram Vasudevan. "Conformalized Reachable Sets for Obstacle Avoidance With Spheres.", arxiv.org/abs/2410.09924, *Corl 2024 SAFE-ROL Workshop,* 2024.
- **Bohao Zhang,** Ram Vasudevan. "Rapid and Robust Trajectory Optimization for Humanoid.", arxiv.org/abs/2409.00303, *Under Review in IEEE ICRA,* 2024.
- **Bohao Zhang*,** Daniel Haugk*, Ram Vasudevan. "System Identification For Constrained Robots" arxiv.org/abs/2408.08830, *Under Review in IEEE Robotics and Automation Letters,* 2024.
- [**RSS'24**] Jonathan Michaux, Adam Li, Qingyi Chen, Che Chen, **Bohao Zhang,** Ram Vasudevan. "Safe Planning for Articulated Robots Using Reachability-based Obstacle Avoidance With Spheres", *Robotics: Science and Systems,* 2024.
- [**RSI'24**] Xun Fu, **Bohao Zhang,** Ceri J Weber, Kimberly L Cooper, Ram Vasudevan, Talia Y Moore. "Jointed Tails Enhance Control of Three-dimensional Body Rotation", arxiv.org/abs/2406.09700, *Royal Society Interface,* 2024.
- Jonathan Michaux, Patrick Holmes, **Bohao Zhang,** Che Chen, Baiyue Wang, Shrey Sahgal, Tiancheng Zhang, Sidhartha Dey, Shreyas Kousik, Ram Vasudevan. "Can't Touch This: Real-Time, Safe Motion Planning and Control for Manipulators Under Uncertainty", arxiv.org/abs/2301.13308, *Under review in IEEE Transactions on Robotics,* 2024.
- [**RAL'24**] Zachary Brei, Jonathan Michaux, **Bohao Zhang,** Patrick Holmes, Ram Vasudevan. "Serving Time: Real-Time, Safe Motion Planning and Control for Manipulation of Unsecured Objects", *IEEE Robotics and Automation Letters vol. 9, no. 3, pp. 2383-2390,* 2024.
- [**RSS'20**] Patrick Holmes, Shreyas Kousik, **Bohao Zhang,** Daphna Raz, Corina Barbalata, Matthew Johnson-Roberson, Ram Vasudevan. "Reachable Sets for Safe, Real-Time Manipulator Trajectory Design", *Robotics: Science and Systems,* 2020.
- [**TRO'21**] **Bohao Zhang*,** Shreyas Kousik*, Pengcheng Zhao*, Ram Vasudevan. "Safe, Optimal, Real-time Trajectory Planning with a Parallel Constrained Bernstein Algorithm", *IEEE Transactions on Robotics, vol. 37, no. 3, pp. 815-830,* 2021.

TEACHING

University of Michigan | Graduate Student Instructor
Sept. 2024 - Dec. 2024 • Ann Arbor, MI

- MECHENG 561: Design of Digital Control Systems.