Haizhou Zhao

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Personal Page

Education

University of Liverpool — **Liverpool, United Kingdom**
B.Eng. in Mechatronics and Robotic Systems - ***First Class (Honours)*** — 2019/09 - 2023/07

Xi'an Jiaotong-Liverpool University (XJTLU) — **Suzhou, China**
B.Eng. in Mechatronics and Robotic Systems — 2019/09 - 2023/07

- GPA 3.86/4.0
- Year 0 (2019-2020) Rank 1. **University Academic Excellence Award** (Top 5%)
- Year 1 (2020-2021) Rank 2. **University Academic Excellence Award** (Top 5%)

Research Interests

- **Hybrid control schemes** that combine model-aware optimization-based control and data-driven learning techniques to enable agile, robust, and adaptive humanoid robot locomotion in the real world.
- **Bionic mechanical design** to enhance humanoid robot athletic abilities and compliance.

Publications

Preprints

- Lei Yu, **Haizhou Zhao**, Siying Qin, and Yuqing Chen. "A Robot Leg with Compact Variable Stiffness Joint based on Leaf-Spring Mechanism". arXiv preprint abs/2308.13988 (Submitted to IEEE/ASME Transactions on Mechatronics, Under Review), 2023.
- **Haizhou Zhao**, Lei Yu, Siying Qin, Yurui Jin, and Yuqing Chen. "Design and Control of a Bio-inspired Wheeled Bipedal Robot". arXiv preprint abs/2308.13205 (Working in progress), 2023.

Conferences

- **Haizhou Zhao** and Yuqing Chen. "Constrained Iterative Nonlinear Optimization for Robot Control Applications". In 2022 27th IEEE International Conference on Automation and Computing (ICAC).

Industrial Experience

Bipedal Robot Walking Control — **Beijing, China**
Control Engineer (co-founder), ARX Robotics (Beijing) Inc. — 2023/06 – 2023/07

- Implemented a DCM + WBC walking controller with footstep and timing optimization for a bipedal robot. The robot could walk stably for more than 1 min.

Research Experience

Bipedal Robot Controller Design — **Tsinghua University**
Research intern, DISCOVER Lab, Institute for AI Industry Research (AIR) — 2022/05 – 2023/05
Advisor: Dr. Guyue Zhou, Associate Professor, AIR, Tsinghua

- Designed an HZD + WBIC walking controller for a bipedal robot with line feet. The robot was capable of performing short-time walking in hardware tests (5 to 10s) .
- Implemented an NMPC + WBC control framework with online foot placement planning based on OCS2. Walking stability was tested successfully in the simulation.
- Programmed a PUB-SUB multi-task framework based on message queues to facilitate unit tests and continuous development.

Bionic Wheeled Bipedal Robot Design and Control — **XJTLU**
Undergraduate Research Assistant, XJTLU Robotics Lab — 2021/09 - 2023/01
Advisor: Dr. Yuqing Chen, Assistant Professor, Dept. of Mechatronics and Robotics, XJTLU

- Built a wheeled bipedal robot with special consideration of the link inertia distribution and controller design to improve torque efficiency inspired by human deep squats.
- Devised a CLF-WBC controller using the wheeled linear inverted pendulum (wLIP) as the reduced-order model to control the centroidal dynamics.

Parallel Variable Stiffness Actuator **XJTLU**
Undergraduate Research Assistant, XJTLU Robotics Lab 2022/08 - 2022/11
Advisor: Dr. Yuqing Chen, Assistant Professor, Dept. of Mechatronics and Robotics, XJTLU

- Involved in the design of a compact leaf-spring-based parallel variable stiffness actuator (P-VSA) to improve torque efficiency and increase joint output power.
- Validated the effectiveness of the P-VSA for realistic humanoid robot leg applications via robot leg hopping experiments. The leg was controlled by a virtual model controller (VMC) as well as a mathematical model of the leaf spring to calculate the P-VSA output torque. The stiffness of the P-VSA was modulated online during hopping.

Input-Constrained Horizon-Variable Nonlinear Differential Dynamic Programming **XJTLU**
Summer Undergraduate Research Fellow 2021/06 - 2021/09
Advisor: Dr. Yuqing Chen, Assistant Professor, Dept. of Mechatronics and Robotics, XJTLU

- Designed an SQP-like indirect optimal control algorithm based on Pontryagin's maximum principle (PMP). The optimal control problem was solved in a Riccati-recursion style to exploit the time sparsity. Input constraints are handled by solving intermediate-step sub-problems formulated as quadratic programming.
- Implemented the numerical simulation for an underactuated planar three-link system in MATLAB. The simulation results are presented in the ICAC 2022 paper.

Competition

DJI RoboMaster Robotics Competition 2022, National 1st Prize **Shenzhen, China**
Control System Group Advisor, XJTLU GMaster Team 2021/08 - 2022/09

- Assisted the controller design for an omnidirectional co-axial self-balancing robot.
- Promoted the analysis and improvement of controller performance based on classical control theory.

DJI RoboMaster Robotics Competition 2021, National 2nd Prize **Shenzhen, China**
Control System Group Leader, XJTLU GMaster Team 2020/08 - 2021/07

- Improved and tuned cascaded-PID + low-pass filtering for 2-DOF gimbals according to classical control theory. The gimbals exhibited rapid responses to commands and excellent robustness against external disturbances and unknown noises.
- Implemented a vision-servo framework that integrated IMU, camera, and Kalman filter for automatic target tracking. The controller latency was explicitly compensated through timestamp calibration and Kalman filter prediction.

Technical Skills

- **Programming:** C++, C, Python, embedded systems (STM32, Arduino, FreeRTOS, etc.), MATLAB
- **Simulation:** Simulink, Simscape Multibody, RaiSim, MuJoCo
- **Libraries:** CasADi, Pinocchio, ROS, ROS2, ACADOS, OSQP, IPOPT, OCS2
- **Mechanical Design:** Solidworks, Ansys