

Zhengzhe Xu

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SUMMARY

Research Interests: My research is primarily focused on **autonomous navigation** for mobile robots, including planning algorithms and optimal control. Currently, I am engaged in research with **visual SLAM**. I am keen to explore the potential of **learning-based methods** in enhancing perception and decision-making.

Highlight: Two years of robotics research experience with a solid mathematical and theoretical background.

Core Courses: Machine Learning, Introduction to Artificial Intelligence, Autonomous Mobile Robot, Automatic Control Theory: Part A (**96**) Part B (**97**), Automatic Control Practice: Part A (**95**), Part B (**94**), Signal Analysis and Processing (**98**), Linear Algebra in Control Theory (**97**), C Language Programming (**95**), System Modeling and Simulation (**95**), Probability Theory and Mathematical Statistics (**98**), Calculus: Part A (**94**), Part B (**92**), Linear Algebra (**92**).

Language Ability: IELTS 7.0 (L7.5 R8.5 W6.5 S6.0)

EDUCATION

Harbin Institute of Technology, Shenzhen

Shenzhen, China

Bachelor's of Engineering (B. Eng.) in Automation (Robotics Track)

Sep. 2020 – Present

- GPA: 94.03/100, 3.97/4.0 (ranking 3/237)
- National Scholarship, 2021 and 2023 (top 0.2% students in China)
- University-Level Exemplary Role Model (academic and research category) (top 0.1% students in HIT)

PUBLICATIONS

- **Zhengzhe Xu***, Yanbo Chen*, Zhuozhu Jian, Xueqian Wang, Bin Liang, “Hybrid Trajectory Optimization for Autonomous Terrain Traversal of Articulated Tracked Robots”, *Under Review, IEEE Robotics and Automation Letters (RA-L)*. [Paper] [Video]
- Yanbo Chen*, **Zhengzhe Xu***, Zhuozhu Jian*, Gengpan Tang, Liyunong Yang, Anxing Xiao, Xueqian Wang, Bin Liang, “Quadruped Guidance Robot for the Visually Impaired: A Comfort-Based Approach”, *IEEE International Conference on Robotics and Automation (ICRA) 2023*. [Paper] [Video]

* indicates equal contribution.

RESEARCH EXPERIENCE

Networked Robotics and Systems Lab, HITSZ

Shenzhen, China

Undergraduate Research Assistant, Advisor: Prof. Haoyao Chen

Aug. 2023 – Present

- A lightweight visual inertial SLAM system is being developed for unmanned aerial vehicles (UAVs) that is capable of robust localization in dynamic environments.

Center for Artificial Intelligence and Robotics, Tsinghua University

Shenzhen, China

Undergraduate Research Assistant, Advisor: Prof. Xueqian Wang

Aug. 2021 – May 2023

- Proposed a novel hybrid trajectory optimization method for articulated tracked robots in traversing uneven terrain, capable of traversing the terrain in a stable and smooth motion.
- Designed and implemented the quadruped guidance robot that automatically can lead the visually impaired to navigate in the narrow space without any collisions while ensuring comfort.

PROJECTS

Autonomous Terrain Traversal of Articulated Tracked Robots

Aug. 2022 – May 2023

- **Research Topics:** Trajectory Optimization, Motion Planning, Field Robot
- Proposed a planar robot-terrain interaction model to simplify the contact patterns. Reduced the dimension of configuration space by generalized coordinates, facilitating real-time planning capabilities.
- Developed a novel hybrid trajectory optimization formulation to generate terrain traversal motions with mode switching. A multi-objective cost function is designed to improve motion efficiency, smoothness, and stability.

- Integrated the map sampling, terrain simplification, and tracking controller modules into a terrain traversal system. Validated the system using the Searcher robotic platform in both simulation and real-world scenarios.
- Compared to expert operator control and the state-of-the-art autonomous method, our method can generate time- and energy-efficient, more stable, and smoother terrain traversing motions.

Quadruped Guidance Robot for the Visually Impaired

Aug. 2021 – Mar. 2022

- **Research Topics:** Model Predictive Control, Motion Planning, Human-Robot Interaction, Quadruped Robot
- Developed a novel autonomous guidance robotic system with a controllable traction device and a planning and control framework based on comfort, allowing for precise traction force control and smooth interaction.
- Proposed a force-based human motion model to describe the “standing-walking” pattern in a robotic guidance system, facilitating traction force planning.
- Proposed a two-stage planning method for human and robot motions to plan the traction force by solving a mixed-integer planning problem and control the force by a traction device to improve comfort.
- Validated the system on the Unitree Laikago quadruped platform through comparative experiments that demonstrated significant improvements in guidance comfort.

Reconfigurable Bionic Hexapod Robot

Dec. 2021 – Jun. 2022

- Designed a hexapod robot with C-shaped legs inspired by the behavior of pill bugs that can curl up into balls. Leveraged the unique C-shaped leg design to provide the robot with exceptional mobility.
- Implemented a modular structure consisting of three partial spherical shells connected by hinges for “linear-spherical” reconfiguration. Leveraged its ability to curl up and utilize potential energy for rolling locomotion, enhancing its mobility and agility in scenes such as grass and dunes.
- Achieved versatile locomotion capabilities, including rolling and crawling modes, by utilizing brushless DC motors connected via CAN bus for precise gait control.

HONORS AND AWARDS

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| National Scholarship | <i>2021, 2023</i> |
| TOPBAND Intelligent Technology Excellence Scholarship | <i>2022</i> |
| First-Class Academic Scholarship | <i>2021, 2022, 2023</i> |
| University-Level Exemplary Role Model (Academic and Research Category) | <i>2023</i> |
| Outstanding Student | <i>2021, 2023</i> |
| First Prize of the 4th China University Intelligent Robot Creative Competition | <i>2021</i> |
| First Prize of the China Undergraduate Mathematical Contest in Modeling in Guangdong | <i>2021, 2022</i> |
| First Prize of the 13th Chinese Mathematics Competitions in Heilongjiang | <i>2021</i> |
| First Prize for Outstanding Freshman Annual Project Plan | <i>2021</i> |

TECHNICAL SKILLS

Languages: C/C++, Python, MATLAB, Wolfram Language, L^AT_EX

Tools: ROS, Gazebo, PyBullet, SolidWorks, Git, Anaconda

Libraries: CasADi, PyTorch, NumPy, OpenCV, PCL, Eigen, SciPy

Hardware: STM32, Jetson Nano, Raspberry Pi, Arduino, multiple motors and sensors, basic mechanical design