

# Zhengzhe Xu

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## SUMMARY

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**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 Proficiency:** IELTS 7.0 (L7.5 R8.5 W6.5 S6.0)

## EDUCATION

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**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

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- **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

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**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

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**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

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**Languages:** C/C++, Python, MATLAB, Wolfram Language, L<sup>A</sup>T<sub>E</sub>X

**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