Zhengzhe Xu

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Summary

Research Interests: My research is primarily focused on **autonomous navigation** for mobile robots, with a strong interest in **motion planning** and **optimal control**. Currently, I am engaged in research related to **visual SLAM**. My goal is to create intelligent and efficient robotic systems to address real-world challenges in cluttered environments.

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

Relevant Courses: 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

Banchelor'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*

- 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.
- 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.

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.

Hornors and Awards

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

Technical Skills

Languages: C/C++, Python, MATLAB, Wolfram Language, LaTeX

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

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

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