Zhengzhe Xu

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Summary

Research Interests: My research is primarily focused on **autonomous planning and control** for mobile robots, with a strong interest in **motion planning** and **optimal control**. 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**).

Education

Harbin Institute of Technology, Shenzhen Shenzhen, China

Banchelor's of Engineering (B. Eng.) in Automation (Robotics Track) (proposed) *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)

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

Center for Artificial Intelligence and Robotics, Tsinghua University Shenzhen, China

Research Assistant, Advisor: Prof. Xueqian Wang *Aug. 2021 – May 2023*

- Designed and implemented the quadruped guidance robot that automatically led 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 moving over obstacles 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, comparing it with expert operator control and demonstrating smoother motion, greater stability, and higher time and energy efficiency.

Quadruped Guidance Robot for the Visually Impaired *Aug. 2021 – Mar. 2022*

- **Research Topics:** Model Predictive Control, Motion Planning, Physical 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 Undergraduate Academic Scholarship	*2021, 2022, 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*

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