

RUIJIE FU

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EDUCATION

Carnegie Mellon University, Pittsburgh, PA
Master of Science in Robotics

Expected 2023

Carnegie Mellon University, Pittsburgh, PA
Bachelor of Science in Discrete Mathematics with a Minor in Robotics

May 2020

RESEARCH EXPERIENCE

High Degree-of-freedom Robot Locomotion - Biorobotics Lab – Pittsburgh, PA

February 2017 - Present

- Designed and Implemented a novel progression gait that allows snake robots to autonomously move along pipes with protruding obstacles and navigate T-junctions
- Developed a framework that extends geometric motion planning methods to systems with cyclic degrees of freedom and validated the approach by prescribing optimal efficiency gait for an n-link swimmer in viscous fluid
- Extended a geometric mechanics-based variational optimization method to optimize high DoF robot locomotion on uneven terrain
- Identified the most efficient gait for a 3-link kinematic system, which is the first to successfully cross the singularity line

Geodesic Complexity of Motion Planning – Pittsburgh, PA

June 2020 - May 2021

- Discovered a metric space that potentially has higher geodesic complexity than topological complexity
- Analyzed the geodesic complexity of a lollipop graph using the stratification method

PROJECT EXPERIENCE

Learning-based Metal Corrosion Prediction – Pittsburgh, PA

July 2022 - Present

- Designed and implemented an autonomous system to collect a temporal sequence of images of carbon steel corroding under constant salt water mist
- Designed and built a network architecture to predict corrosion and defects on metal pieces

Pointcloud Data Mesh Generation – Pittsburgh, PA

March 2022 - Present

- Created high accuracy meshes from pointcloud data utilizing skills in discrete differential geometry

Mapping and Localization – Pittsburgh, PA

March 2020 - April 2022

- Developed a tightly coupled simultaneous localization and mapping (SLAM) algorithm for aggressive motion in indoor environments, leveraging the unique flower-shaped scan pattern of Livox LiDAR
- Improved sequence SLAM implementation by using a hierarchical structure, particle filter, and parallel graph isomorphism algorithm
- Applied the sequence SLAM implementation to the development of a LiDAR data processing framework for assembling a large number of map segments into a complete map

ARPA-E in-pipe SLAM – Pittsburgh, PA

March 2020 - January 2022

- Overcame the lack of good features inside pipes by fusing sensor data from LiDAR, camera and ring laser
- Significantly improved feature matching accuracy, allowing for an average of 1% longitudinal drift in robot localization inside the pipe
- Enabled real-time, colored 3D reconstructions of pipe surfaces with an average of 0.16% error in pipe diameter

Iris Lunar Rover - CMU Planetary Robotics Lab – Pittsburgh, PA

January 2019 - March 2020

- Designed ground operation code translation chart and co-designed teleoperation software structure
- Coded and built flight software modules using Magicdraw

Forklift - Mobile Robot Programming – Pittsburgh, PA

August 2018 - January 2019

- Implemented code for a robot to automatically distinguish pallets from walls, plan an efficient cubic spiral path to pick up pallets, and navigate to a designated area
- Served as teaching assistant for a class that used this project as the final project, explaining essential concepts in mobile robots such as particle filters and triangulation to students and guiding them through the project

MAIN PUBLICATIONS

- **Ruijie Fu**, Ross Hatton, Howie Choset, "Geometric Motion Planning for Systems with Cyclic Shape Spaces", IEEE International Conference on Robotics and Automation (*ICRA*) 2023. (in manuscript)
- Ross L. Hatton, Zachary Brock, Shuoqi Chen, Howie Choset, Hossein Faraji, **Ruijie Fu**, Nathan Justus and Suresh Ramasamy, "The Geometry of Optimal Gaits for Inertia-dominated Kinematic Systems", IEEE Transactions on Robotics (*TRO*).
- Shuoqi Chen, **Ruijie Fu**, Ross L. Hatton, Howie Choset, "Towards Geometric Motion Planning for Systems on Cylindrical Surfaces", International Conference on Intelligent Robots and Systems (*IROS*) 2021.
- Peng Yin, Haowen Lai, Shiqi Zhao, **Ruijie Fu**, Ivan Cisneros, Ruohai Ge, Ji Zhang, Howie Choset, Sebastian Scherer, "AutoMerge: A Framework for Map Assembling and Smoothing in City-scale Environments", IEEE Transactions on Robotics (*TRO*). (accepted)

SKILLS

Programming languages: Python, C++, Matlab, C, SML; **Robotics middleware and software:** ROS, Pybullet, Gazebo, MagicDraw; **Machine Learning:** Pytorch, Tensorflow; **Mathematical specialization:** Differential geometry (both continuous and discrete)

SELECTED CLASSES

Programming: Algorithm design; Parallel programming; Machine learning; Computer vision; Computer graphics; SLAM
Mathematics: (discrete) differential geometry; graph theory; topology; combinatorics; probability; abstract algebra; analysis