Ruiji Liu

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EDUCATION

Carnegie Mellon University Sep. 2022 - May 2024
Master of Science in Mechanical Engineering, Robotic and Control Systems *Pittsburgh, PA*
- **GPA:** 4.0/4.0 **Advisor:** George A. Kantor
- **Core Modules:** AI Safety, Modern Control Theories, Robot Localization and Mapping, Computer Vision

The Pennsylvania State University Sep. 2018 - May 2022
Bachelor of Science in Mechanical Engineering *State College, PA*
- **GPA:** 3.98/4.0, Dean's List from Fall 2018 to Spring 2022
- **Core Modules:** Intro Robotics, Modeling Dynamics System, Dynamics, Effective Speech
- **Honor:** Multi-Campus Research Experience Scholarship for Undergraduates

PUBLICATIONS & TECHNICAL REPORTS

[1] **Ruiji Liu**, Francisco Yandun, George Kantor, "LiDAR-Based Crop Row Detection Algorithm for Over-Canopy Autonomous Navigation in Agriculture Fields", in *IEEE International Conference on Robotics and Automation (ICRA)*, 2025. (Under review) [Paper], [Slides], [Project page]

[2] Saira Hussain, Yuqi Zhou, **Ruiji Liu**, Eric Pauli, Randy Haluck, Barry Fell, Jason Moore, "Evaluation of Endoscope Control Assessment System for Measuring", in *Design of Medical Devices Conference*, 2022. [Paper]

[3] **Ruiji Liu**, Francisco Yandun, David Wettergreen, George Kantor, etc., "AIIRA Autonomous Robot Control for Spotted Lanternflies", Technical report (Research). [Paper], [Project Page], [Slides], [Video]

[4] **Ruiji Liu**, Xiaoyang Zhan, Yumeng Xiu, Yufeng Ren, Hanjiang Hu, Zixuan Zhang. "3D Reconstruction for Tunnel Inspection Based on RGB-D Data", Technical report (CMU-16833). [Paper], [Code]

[5] **Ruiji Liu**, Morgan Mayborne, Vina Wei. "Push-T Experiment with Diffusion Policy and DQN", Technical report (CMU-16831). [Paper], [Code], [Data]

[6] **Ruiji Liu**, Letian Leng, Yutong Huang. "Defend Like-a-Lion: Defensive Racing Maneuvers Utilizing Visual Localization", Technical report (CMU-16663). [Paper], [Code] (code need to be published)

[7] **Ruiji Liu**, Yu Qiu, Runpu Meng, Zongyuan Wu. "Finding Optimal Machine Learning Regression Model for House Prices Prediction", Technical report (CMU-24787). [Paper], [Code]

[8] A. Anand, C. Frantz, .., **Ruiji Liu**, etc., "The Pennsylvania State University Advanced Vehicle Team's Concept Design for the SAE AutoDrive Challenge II Competition's Perception Cart", Technical report, 2022. [Paper]

[9] **Ruiji Liu**, Ryan Maziarz, Alex Nellis. "Autonomous Etch-A-Sketch", Technical report, 2021. [Paper], [Video], [Code]

[10] **Ruiji Liu**, Alan Wagner. "Automatic Path-Planning and Map Drawing by Husky Robot and the Realization of Robot Simulation in Unity", Technical report, 2021.[Paper], [Talk], [Demo]

ACADEMIC EXPERIENCE

AIIRA Crop-Agnostic Autonomous Navigation on Amiga Robot Platform May 2023 – Present
Research Assistant @ CMU KantorLab, supervised by Dr. George A. Kantor *Pittsburgh, PA*
- **High-Precision Robot Localization:** Integrated the ROS robot localization package on the Amiga robot, fusing sensors' outputs from IMU, RTK-GPS, and wheel encoder to enhance robot localization accuracy
- **Drone Map:** Generated multiple drone maps with position accuracy within 3cm using RGB-D images from the drone across various crop fields
- **MPC Controller:** Designed and implemented a custom Model Predictive Control (MPC) controller, enabling the robot to follow predefined navigation paths (from the drone maps) autonomously and significantly reducing the need for human intervention (tested in fields)
- **General Crop Detection Algorithm:** Developed a novel LiDAR-based, crop-agnostic detection algorithm to address crop row detection challenges across various crop types and growth stages, demonstrating the effectiveness in crop row detection through testing in both the Gazebo simulation environments and real fields
- **Autunomous Navigation without RTK-GPS:** Combined the LiDAR-based crop row detection algorithm with a modified local MPC controller to achieve autonomous navigation in crop fields without RTK-GPS. Tested in corn and soybean fields at different growth stages, both in Gazebo simulations and real field conditions

F1 TENTH Autonomous Race Vehicle Jan. 2024 – May 2024
CMU 16663 Course Info *Pittsburgh, PA*
- **Built the F1TENTH Car:** Built the F1 TENTH vehicle from scratch, assembling the chassis, installing the compute module (Jetson Orin Nano & SSD cards), integrating sensors (Hokuyo LiDAR & cameras), and setting up Ubuntu 20.04 with ROS 2 Foxy
- **Implemented the Autonomy algorithms:** Devised and implemented various autonomy algorithms on a self-built F1 TENTH vehicle for racing. These included perception (computer vision & SLAM), planning (RRT & Gap following), control (PID, Pure Pursuit, & MPC), and machine learning techniques (YOLO, imitation learning, & reinforcement learning)

- **Racing the vehicles:** Tested our autonomous navigation algorithms rigorously during three race days within the school (reactive racing, racing with map, & head-to-head race). Competed against approximately 10 teams from UPenn and Lehigh
- **Autonomous Defensing strategy:** Devised an autonomous defense system for F1TENTH vehicles, including a defensive path-planning algorithm and a YOLOv8 object detection model using the rear-facing camera

- **AIIRA Autonomous Robot Control for Spotted Lanternflies**   Feb. 2023 – May 2023
  Research Assistant @ CMU KantorLab, supervised by Dr. George A. Kantor   *Pittsburgh, PA*
  - **Spotted Lanternflies Detector:** Applied YoloV5s model to train a Spotted Lanternflies detector based on 3000 images from the iNaturalist website (The dataset was augmented from 700 images through rotation, skewing, and scaling)
  - **Robot in Simulation:** Constructed a URDF model for the Amiga robot to evaluate sensor configurations and autonomous algorithms in the Gazebo simulation environment
  - **Final Results:** Validated the feasibility of the robot control method using artificial fake lanternfly eggs with an 80 % success rate and presented the project at the USDA-NIFA/NSF Annual Review poster session

- **Endoscope Control Assessment Using Video and Magnetic Tracking**   Sep. 2021 - May 2022
  Research Assistant, supervised by Dr. Jason Moore   *State College, PA*
  - **Magnetic Tracking Technology:** Utilized a magnetic tracker to precisely monitor the tip movement of the endoscope within the colon, providing high-precision tip location data, aiding in the accurate measurement and analysis of the endoscope's path and curvature during operation
  - **Video Angle Capture:** Devised CV algorithms to capture the angle changes of the endoscope control knobs, enabling real-time quantification of the operator's input on the controls, enabling the system to thoroughly record and evaluate the operator's control techniques and performance across different stages of the procedure
  - **Integrated Data Analysis:** Compared results of the endoscope tip movement data and the control knob angle data, and provided well-rounded feedback by employing advanced data analysis algorithms

- **Automatic Path-Planning and Map Drawing**   Jun. 2021 - Aug. 2021
  Research Assistant @ PSU REAL Lab, supervised by Dr. Alan Wagner   *State College, PA (Remote)*
  - **Autonomous Obstacle Avoidance:** Applied ROS and devised bug2 algorithm in Python to enable autonomous obstacle avoidance for the Husky robot
  - **ROS and Unity Integration:** Utilized ROS-TCP-Connector to integrate ROS with Unity, developed odometry and laser data publishers, along with a velocity subscriber, enabling robot simulation within Unity

Teaching Experience

- **Teaching Assistant**
  ME 24787, Introduction to Machine Learning, CMU   *Sep. 2023 – Dec. 2024*
  - Organized weekly office hours and participated in student's final project design & revision
  - Implemented project Q&A sessions, evaluated project completion, and provided follow-up

- **Grading Assistant**
  ME 330, Computational Tools, Penn State Univeristy   *Jan. 2022 – May. 2022*
  - Graded 200+ students weekly homewor
  - Attended weekly meetings with professors and proposed Quiz questions

- **PSU RoboX Club Machinery Group Leader**
  Machinery Group, Penn State Univeristy   *Jan. 2020 – May. 2022*
  - Designed Routine training handbooks & slides, and delivered technical lectures to the new-coming members
  - Devised robot models with SolidWorks and produced components in the university's factories
  - Won 1V1 Confrontation Champion in Robomaster University League North America in 2021

Skills

- **Programming:** Advanced – Python, Intermediate – C++, C#, Beginner – R, Julia
- **Application Software:** ROS, OpenCV, MATLAB, Gazebo, SolidWorks, Unity, CATIA V5
- **Languages:** English (fluent), Chinese (native)