Ruihan Xu (Multy)

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EDUCATION

University of Michigan – Ann Arbor **Ann Arbor, Michigan**
Bachelor of Science in Computer Science Honor Degree, Math minor Aug 2022 - Dec 2024

- **GPA**: 4.0/4.0
- **Honors/Award**: University Honor (Dean list) for 4 semesters, James B. Angle Scholar
- **Course Highlights:**
  - Graduate level: Self-Driving Vehicle, Mobile Robotics, Continuous Optimization Methods, Human-Robot Interaction
  - Undergraduate level: Machine Learning, Computer Vision, Autonomous Robot, Large Language Models
- Research Assistance
  - Laboratory for PROGRESS (L4P) led by Professor Chad Jenkins 08/2023 – 07/2024
  - Computational Autonomy and Robotics Laboratory (CURLY) led by Professor Maani Ghaffari 08/2023 – 07/2024

RESEARCH EXPERIENCE & PUBLICATION

Latent BKI: Open-Dictionary Continuous Mapping in Visual-Language Latent Spaces with Quantifiable Uncertainty 11/2023 – Current

- Designed and implemented the Latent Bayesian Kernel Inference algorithm for latent map update.
- Constructed and tested method to quantify uncertainty in the latent space using sampling, D-optimality, E-optimality.
- Demonstrated real world usage using iPad and constructed real world map of an indoor environment.
- Applied open-dictionary query in real world map to find anything matched with description
- Under review in RA-L (Robot Autonomous Letter) as co-first author.

Single-View 3D Reconstruction via SO(2)-Equivariant Gaussian Sculpting Networks[arXiv][video] 11/2023 – 07/2024

- Designed and implemented Gaussian Sculpting Network (GSN) with ResaNet backbone and multi-layer perceptron.
- Constructed new Extended Chamfer Distance suitable for loss calculation between Gaussian Splats to ensure equivariance.
- Applied GSN to Robot simulation using Pybullet to test applicability of network in robot manipulation tasks.
- GSN achieve comparable performance in visual quality and faster inference speed compared to the SOTA model.
- Accepted to and presented at RSS workshop on Geometric and Algebraic Structure in Robot Learning as first author

Stein Variational Belief Propagation for Multi-Robot Coordination [arXiv][video][Website] 07/2023 – 01/2024

- Facilitated the creation of a message passing method (MBot Bridge) between robots (MBot) using WebSocket allowing the robot to sequentially update their message/belief for other robots.
- Devised an MPC-style velocity controller for the robot to follow the trajectory published in MBot Bridge to realize Stein Variational Belief Propagation (SVBP) developed in simulation.
- Conducted real-world experiment with 3 MBots in 4 different designed environments with obstacles to test SVBP algorithm and record 30 experiment videos for performance analysis.
- Accepted to RAL (Robot Autonomous Letter) as the third author.

SURE (Summer Undergraduate Research Experience) – MBot Development 05/2023 – 08/2023

- Developed a new image recognition function using OpenCV with an improved computer vision algorithm to extract shapes from sticky notes, being used for a project for an undergraduate robotics course.
- Fixed message-passing issue in LCM to let SLAM and autonomous navigation algorithm adapt to the new robot firmware.
- Created testing script in C for new robot firmware to calibrate odometry, lidar reading, and PID control.

U of R Summer Research Project – Multispectral Imaging Processing on Culture Heritage 05/2022 – 08/2022

- Mastered the math of SVD (Singular Value Decomposition), PCA (Principal Component Analysis), and linear regression with a focus and application on training image recognition and reconstruction using MATLAB.
- Designed an algorithm to sample images under light with multiple spectrums and reconstruct the material reflectance spectrum to reveal the hidden detail that cannot be seen by the human eye by applying SVD, and PCA.

WORK EXPERIENCE

University of Michigan Robotics Department **Michigan, US**
Rob 102 - Instruction Aide 08/2023 – 12/2023

- Created modified course projects, particularly the MBot project for autonomous navigation with computer vision algorithms.
- Facilitated Lab session each week by teaching project specific programming skills and providing help to students with difficulties

Rob 303 - Instruction Aide 08/2024 – Current

- Written comprehensive MBot setup and use instructions for student to easily use NoMachine, VSCdoe with MBots.

STEM PROJECTS

UMDrive: Towards Robust and Safe SLAM on Real-World Scenarios – UM ROB 530 03/2024 – 05/2024

- Created real-world outdoor video dataset with various weather condition, camera poses reconstructed by SFM (structure from motion) using Colmap
- Evaluate several state-of-the-art visual SLAM models for in-door 3D reconstruction on outdoor dataset augmented with noise.

Monocular Camera 3D Object Detection for Autonomous Vehicle – UM ROB 535 10/2023 – 12/2023

- Finetuned the 3D detection model based on MonoCon and adopted data augmentation for images presented in foggy environment.
- Produced 4 pages of CVPR paper format report with detail comparison and analysis with other similar detection model.

Human-Object Interaction (HOI) Detection – UM EECS 442 **10/2023 – 12/2023**
- Led team of 4 to create a neural network that detect possible interaction between human and object in an image.
- Devised the PyTorch dataloader for the VCOCO data set for training.
- Implemented and fine-tuned the neural network pipeline using YOLOv8 with additional convolutional layers, and Multi-layer Perceptron (MLP).

A Review for Human-Robot Handover – UM ROB 599 **08/2023 – 12/2023**
- Produced 8 pages IEEE conference paper format review paper by reviewing more than 40 papers on Human-Robot Handover problem.
- Devised a toy example using neural network to detect human handover action.
- Idea been adopted as a formal research project by the professor.

Islandr – Web Design for Students Organizations **08/2019 – 06/2020**
- Programmed email system and daily bulletin webpage using html, css, MySQL, Flask, and Python.
- Launched the website in school by presenting the prototype to everyone in the school in the assembly hall.

Blue Turtle – Computer Vision Based Depression Monitoring and Prevention– Summer Hackathon **07/2019 – 08/2019**
- Led team of three and created a machine learning algorithm for detecting potential depression through people's facial expressions using Python TensorFlow library, and Microsoft Azures.
- Designed an autonomous robot with Lidar that goes around campus using ROS.
- Awarded as the 8 best projects in the competition for the degree of technical completion and social value.

LEADERSHIP

Blue Record Student Band Group E-board **08/2023 – Current**
- Led team of 20 to form bands to perform at major university shows, and organized practice sessions, workshop, recording sessions.
- Organized large event "Blue Record Music Festival" with 250 attendances and over 50 performers.

First Robotics Competition **12/2017 – 08/2021**
- As Co-founder, vice president, programming lead (Team 6394 & 7280), train new members.
- Programmed computer vision for object detection for robot automation in grabbing, ball shooting, motion planning using raspberry Pi, Java, Python and OpenCV.

TECHNICAL SKILLS

- Programming language: Python, C++/C, MATLAB, Java.
- Machine Learning: PyTorch, OpenCV
- Robot Control: MPC, vehicle dynamics, trajectory optimization with CasADI in Python
- Robotics system and simulation: ROS, Gazebo, Pybullet
- Web development: PHP, MYSQL, Script, Python, HTML, CSS