ZIXUAN WU

266 Ferst Dr NW, Atlanta, GA, USA
zwu380@gatech.edu | +1 (404) 457-0531| LinkedIn | Scholar

EDUCATION

Georgia Institute of Technology (GPA: 4.0/4.0) Atlanta, GA, USA
Ph.D., Electrical and Computer Engineering 10/2021-present
Thesis: *Model-assisted Reinforcement and Imitation Learning in Multi-Robot Systems*
Advisor: Matthew Gombolay

Georgia Institute of Technology (GPA: 3.81/4.0) Atlanta, GA, USA
MS, Electrical and Computer Engineering 08/2019-10/2021
Thesis: *Trajectory Servoing: Image-Based Trajectory Tracking without Absolute Positioning*
Advisor: Patricio A. Vela

Harbin Institute of Technology (GPA: 91.5/100) Harbin, Heilongjiang, China
B.E., Control Science and Engineering 09/2015-08/2019
Thesis: *An Investigation on IBVS and PBVS Control Techniques and Their Applications*
Advisor: Weiyang Lin

RESEARCH EXPERIENCE

Bosch AI Silicon Valley Sunnyvale, CA, USA
Research Intern, CR/RHI2-NA 05-08/2025
Keyword: *Foundation Model, Generative Model, Scene Understanding, Autonomous Driving*
1. Cross-domain Autonomous Parking Pipeline Training with Generative and Foundation Model

- Pioneer a modular autonomous parking pipeline that decouples perception, planning, and trajectory tracking such that the pipeline will not be overfit to the training set.
- Obtain generalizable vehicle Bird-eye-view (BEV) representations from DINOv2 and Lift-Splat-Shoot (LSS) visual geometry. Achieve diverse and robust trajectory modeling via dataset relabeling and diffusion models.
- Our pipeline can achieve >90% success rate even in the out-of-distribution (OOD) test environment visually different from the training and show the zero-shot transferability to the reconstructed 3D Gaussian Splatting world, which significantly beat the baselines.

Georgia Institute of Technology Atlanta, GA, USA
Graduate Research Assistant, Interactive Computing 10/2021 – Present
Keyword: *Reinforcement and Imitation Learning, Multi-Agent System, Perception and Planning*
1. Heterogeneous search and tracking via model-based reinforcement learning (RL)

- Develop two large partially observable domains – Prisoner Escape and Narco Interdiction setting for search and evading adversarial games.
- Design a novel prior-motion-combined (PMC) filter which incorporates the motion model and agent behavior pattern to estimate the evader's location from multi-Gaussian

hypothesis and outperforms the baselines by 18.03%.
- Include the evader location parameters into the searching team RL's observation, which greatly improves the exploration and sample efficiency. Our method improves the detection rate by 46%.

2. *Hijacking robot team communications via model-based RL*
   - Build agent behavior and communication models from offline observation-only data.
   - Train black-box attacking policy to robot communications with the gradient generated from and passing through the learned agent model.
   - Validate our adversarial attacking method by comparing it with white noise jamming baseline and achieves 201% decrease of the team reward.
3. *Adversarial evading via diffusion-RL based hierarchical motion planning*
   - Propose a novel hierarchical system consisting of a diffusion model as a high-level global path planner to aid RL exploration and a low-level RL agent to learn evasive maneuvers, which outperforms all baselines by 51.4%.
   - Design an algorithm to implicitly infer the cost map that is used to select path within our hierarchical motion planning framework to evade the searching agents and show the interpretability, flexibility, efficiency and generalizability of our method.
   - Equip evaders with hierarchical motion planning to learn escaping while reaching navigation goal in large partially observable environments without expert primitives.
4. *Tennis court real-time perception and localization with sensor fusion*
   - Debug the wall cameras and ESTHER wheelchair robot perception system such that they can feedback vision and lidar signals.
   - Extract and assort lines on the image space and identify their mapping to Cartesian space.
   - Derive a nonlinear optimization framework to estimate wheelchair location with court line geometry and detect tennis ball and players with YOLO network.
5. *Imitating wheelchair navigation and teaming from broadcast videos via physical model*
   - Propose a novel zero-shot knowledge transferring framework with a diffusion motion planner to tackle the web video learning problem in agile navigation under adversarial settings with OOD task space.
   - We design a real-time feedback planning-control system, including a PD controller guided by our IL policy, and deploy it to a real robot on a real tennis court. Our method achieves a success rate of 68.49% in the real-world real-time experiment.
   - Learn wheelchair teaming strategies with human players using Graphical Neural Network (GNN) and double tennis videos.

Georgia Institute of Technology Atlanta, GA, USA

Graduate Research Assistant, Electrical and Computer Engineering 10/2021 – 08/2019

Keyword: *Image-based Trajectory Servoing, Visual Geometry*

6. *Cartesian trajectory following with image feature based visual tracking under uncertainty*
   - Develop an image-based visual servoing system for a mobile robot to track a global Cartesian trajectory by warping into feature trajectories maintained by ORB-SLAM. Our method outperforms baselines by 28.36% in short trajectory tracking and 26.74% in long trajectory tracking.
   - Weighted feature contributions to IBVS by analyzing their uncertainties using

generalized least square and regularization methods. This further improves our trajectory servoing method performance by 14.39% and 12.96% in short and long trajectory tracking.

Harbin Institute of Technology Harbin, Heilongjiang, China
Undergraduate Research Assistant, Control Science and Engineering 07/2019 – 08/2018
Keyword: *Manipulator, Visual Servoing*

7. *Power optical port detection and tracking with monocular camera on the manipulator*
   - Do comparative study of PBVS/IBVS on a manipulator to track object identified by Single Shot MultiBox Detector (SSD).

TEACHIING EXPERIENCE

Georgia Institute of Technology Atlanta, GA, USA (01/2025 – 05/2025)
Teaching Assistant – Interactive Robot Learning (CS 7648)

- This course mainly focuses on learning from demonstration and active learning. I am the only TA to design tests, grade homework and exams, host office hours, proctor and calculate final grades etc.

Georgia Institute of Technology Atlanta, GA, USA (08/2021 – 06/2022)
Head Teaching Assistant –Introduction to Signal Processing (ECE 2026)

- This course is an introduction to discrete-time signal processing and linear systems. My role as head TA is to coordinate TA tasks with instructors, instruct experiment sessions, grade homework and exams, host office hours, proctor and calculate final grades etc.

Georgia Institute of Technology Atlanta, GA, USA (06/2022 – 08/2022)
Teaching Assistant –Architecture, Systems, Concurrency and Energy in Computation (ECE3058)

- This course is an introduction to basic organizational principles of the major components of a processor. My role as TA is to host office hours and grade homework and exams.

PUBLICATIONS

Dino-Diffusion Modular Designs Bridge the Cross-Domain Gap in Autonomous Parking
IEEE International Conference on Robotics and Automation (ICRA) ***[in submission]*** **2025**
Zixuan Wu, Hengyuan Zhang, Ting-Hsuan Chen, Yuliang Guo, David Paz, Xinyu Huang, Liu Ren

AI-Based Decision Support in Cardiopulmonary Bypass for Perfusionist **2025**
Hamlyn Symposium on Medical Robotics
Zhaoxin Li, Manisha Natarajan, Letian Chen, **Zixuan Wu**, Paul Ogara, Paulo Borges, Geoff Rance, Rithy Srey, Ryan E. Harari, Marco A. Zenati, Roger D. Dias, Matthew Gombolay

Diffusion-Reinforcement Learning Hierarchical Motion Planning in Adversarial Multi-agent Games **2025**
IEEE Robotics and Automation Letters (RA-L) ***[in submission]***
Zixuan Wu, Sean Ye, Manisha Natarajan, Matthew C. Gombolay

Learning Wheelchair Tennis Navigation from Broadcast Videos with Domain Knowledge Transfer and Diffusion Motion Planning **2024**
IEEE International Conference on Robotics and Automation (ICRA)
Zixuan Wu†, Zulfiqar Zaidi†, Adithya Patil†, Qingyu Xiao, Matthew Gombolay (†Equal contribution)

Learning Diverse Robot Striking Motions with Diffusion Models and Kinematically Constrained Gradient Guidance **2024**
IEEE International Conference on Robotics and Automation (ICRA)
Kin Man Lee, Sean Ye, Qingyu Xiao, **Zixuan Wu**, Zulfiqar Zaidi, David D'Ambrosio, Pannag Sanketi, Matthew Gombolay

Learning Dynamics of a Ball with Differentiable Factor Graph and Roto-Translational Invariant Representations **2024**
IEEE International Conference on Robotics and Automation (ICRA)
Qingyu Xiao, **Zixuan Wu**, Matthew Gombolay

Learning Multi-Agent Coordination for Replenishment at Sea **2024**
IEEE Robotics and Automation Letters (RA-L)
Byeolyi Han, Letian Chen, Rohan Paleja, **Zixuan Wu**, Sean Ye, Esmaeil Seraj, David Sidoti, Matthew Gombolay

Using ML for Perfusionists' Decision Prediction for Robotic-Assisted Cardiopulmonary Bypass in Cardiac Surgery **2024**
Hamlyn Symposium on Medical Robotics
Zhaoxin Li, Manisha Natarajan, Letian Chen, **Zixuan Wu**, Paul Ogara, Paulo Borges, Geoff Rance, Rithy Srey, Ryan E. Harari, Marco A. Zenati, Roger D. Dias, Matthew Gombolay

Diffusion Based Multi-Agent Adversarial Tracking **2023**
International Symposium on Multi-Robot & Multi-Agent Systems (MRS) ***[Oral Talk, 35%]***
Sean Ye, Manisha Natarajan, **Zixuan Wu**, Matthew C. Gombolay

Adversarial Search and Tracking with Multiagent Reinforcement Learning in Sparsely Observable Environment **2023**
International Symposium on Multi-Robot & Multi-Agent Systems (MRS) ***[Oral Talk, 35%]***
Zixuan Wu†, Sean Ye†, Manisha Natarajan, Letian Chen, Rohan Paleja, and Matthew C. Gombolay (†Equal contribution)

Hijacking Robot Teams Through Adversarial Communication **2023**
7th Annual Conference on Robot Learning (CoRL) ***[Oral Talk, 6.6%]***
Zixuan Wu, Sean Ye, Byeolyi Han and Matthew C. Gombolay

Learning Models of Adversarial Agent Behavior under Partial Observability **2023**
International Conference on Intelligent Robots and Systems (IROS)
Sean Ye†, Manisha Natarajan†, **Zixuan Wu†**, Rohan Paleja, Letian Chen, and Matthew C. Gombolay (†Equal contribution)

Teleoperation of Semi-autonomous Robots Through Uncertain Environments **2022**

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2022 Opportunity Research Scholars Symposium (ORSS)
Raymond Jia, Nathanael Koh, Nicholas Leone, Mohit Singh, **Zixuan Wu**, Patricio Vela

Image-Based Trajectory Tracking Through Unknown Environments Without Absolute Positioning **2021**
IEEE/ASME Transactions on Mechatronics (TMECH)
Shiyu Feng†, **Zixuan Wu†**, Yipu Zhao and Patricio A. Vela (†Equal contribution)

INDUSTRAIL EXPERIENCE

Bosch AI Silicon Valley - Sunnyvale, USA 05-08/2025
Research Intern, Mentor: Yuliang Guo

- Augment CARLA demonstrations with visual foundation model (e.g. Cosmos, DINO)
- Design Dino-Diffusion autonomous parking pipelines that can transfer across domains
- Validate diffusion policy performance in Gaussian-Splatting rendered real-world parking

Rockwell Automation – Xi'an Branch, China 07-08/2018
Assistant Engineer

- Take responsibility regarding the network connection topology and PLC firmware update
- Test the digital and analog input and output models, then participate in the Factory Acceptance Test
- Servomotor's motion control, system debugging, and parameter tunning

ACADEMIC ACTIVITY

Workshop organizer of "*RoboLetics 2.0: Workshop on Athletic Robots and Dynamic Motor Skills @ ICRA*" 2025
Reviewer of *CoRL, ICRA, IROS* and *RA-L* 2021-2025
Mentor of ECE *Opportunity Research Scholars' Program (ORS)* 2021

HONORS & AWARDS

Otto F. and Jenny H. Krauss Fellowship Endowment for the School of Electrical and Computer Engineering 2021
2nd Prize, Contemporary Undergraduate Mathematical Contest in Modeling 2017
1st Prize, National College Students Mathematical Competition 2016
3rd Prize, Chinese Physics Olympiad 2014
2rd Prize, Chinese Mathematical Olympiad 2014

SKILLS

- Design visual servo and hybrid control strategies, analyze uncertainties and perform sensor fusion algorithms
- Design, implement and debug novel reinforcement learning and imitation learning techniques for robots and autonomous agents
- Software Tools: LaTeX, ROS1, ROS2, CARLA, C++, MATLAB, Python, Pytorch, Deep Graph Library, OpenCV, NumPy

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