Yancheng Zhu

(+1)617-999-7341 | jerryzhu@bu.edu | http://www.yanchengz.com/ | zycjerry | 398 Cambridge St, Allston, MA, US

Education

Boston University *Boston, MA*

PhD in Mechanical Engineering (GPA:3.9/4.0) Sep. 2020 - Expected Jun. 2025

Columbia University *New York, NY*

MS in Mechanical Engineering (GPA:3.6/4.0) Sep. 2018 - Jun. 2020

Tongji University *Shanghai, CN*

BS in Aircraft Engineering (GPA:4.5/5.0) Sep. 2013 - Jun. 2017

Major Concentration: Algorithms, Control System, Optimal Control, Robotics, Motion Planning, Machine Learning

Technical Skills

Programming C++, Python, MATLAB, Java, JavaScript, HTML, SQL

Techniques Visual Studio, Linux, ROS, PyTorch, Gazebo, Simulink, MySQL, Solidworks, Django, Vmware, Docker, Git

Work Experience

Boston University Robotics Lab *Boston, MA*

Graduate Research Assistant Sept. 2020 - Jun. 2025

- In **WSN** (Wireless Sensor Network) research, designed **MPC** (Model Predictive Control) approach for online signal model estimating based on the **FIM** (Fisher Information Matrix) and **MLE**(Maximum Likelihood Estimator).
- In the **UAVs**(Unmanned aerial vehicles) based data harvesting research, designed and implemented the **MIMO**(Multi-input multi-output) data transmission scheme for the flying drones and ground sensors in the **Optitrack** system and **ROS**(Robot Operating System) platform.
- Developed a novel event driven online-feedback close-loop **Optimal Control** algorithm for **Multi-agent** UAV system to collect data from multiple sensors in a large scale environment using **Hamiltonian Analysis**.
- Built **CLF-CBF**(Control Lyapunov Function - Control Barrier Function) based safety guaranteed trajectory tracking controller for UAVs to harvest data from sensors in an un-safety area with flying height constraint.
- Collaborated on implementation of **Reinforcement Learning** with **DDQN** and **PPO** by using **Python** and **PyTorch**, for multi-agent data harvesting system in a high-dimensional working space. Overcome the sparse reward problem, increasing the success rate to 91%.
- Collaborated on **MRI** (Magnetic Resonance Imaging) reconstruction using **Deep Learning** method, which is called **RNST** (Regularization by Neural Style Transfer).

Research Projects

Receding Horizon Control Method for Moblie Robot based Signal Model Estimation *Boston, MA*

BU Robotics Lab, Boston University Dec. 2022 - Sep. 2023

- Formulated an optimization problem to minimize the estimation error for **RSS** (Received Signal Strength) model in a **WSN** (Wireless Sensor Network) by applying a **MPC** (Model Predictive Control) method.
- Applied a **FIM**(Fisher Information Matrix)-based **RH** (Receding Horizon) controller for agent motion planning and used **MLE**(Maximum Likelihood Estimator) for signal model estimation in real time.
- Analysed the **FI** (Fisher Information) distribution in the space for unknown parameters and modified the cost function that seeks to balance the information across all parameters from the FIM, decreasing the estimation error significantly.

Multi-agent Robust and Optimal Policy Learning for Data harvesting *Boston, MA*

BU Robotics Lab, Boston University Sep. 2022 - Aug. 2023

- Proposed a multi-agent **Mobile Robot** data harvesting problem and developed a **DRL** (Deep Reinforcement Learning) solution to the time-optimal optimization.
- Applied a learning policy **PPO** (Proximal Policy Optimization) to control agent in a continuous action space, which exhibited **Robustness** to disturbances through the use of regularization for policy smoothing.
- Utilized prioritized sampling of the replay buffer in **DDQN** (Double Deep Q-Network) to improve the learning efficiency and overcome the sparse reward problem by applying binary reward function.

MRI Field-transfer Reconstruction with Regularization by Neural Style Transfer *Boston, MA*

BU Robotics Lab, Boston University May. 2022 - Jun. 2023

- Proposed a **RNST** (Regularization by Neural Style Transfer) method in **MRI** (Magnetic Resonance Imaging) reconstruction for high-quality images from noisy low-quality images.
- Updated the reconstructed high-quality image from a noisy low-quality image with different image styles and limited data by applying **NST** (neural style transfer) **Deep Learning** engine and a denoiser.
- Validated RNST with clinical MRI scans from 1.5T and 3T and show that RNST can significantly boost image quality, increasing SSIM (Structural Similarity Index) from 0.48 to 0.84 and PSNR (Peak-signal-to-noise Ratio) from 20.66 to 25.16.

Optimal Control Policy for Data Harvesting in Mobile Wireless Sensor Network

Boston, MA

BU Robotics Lab, Boston University

Sep. 2021 - May. 2023

- Proposed an event-driven optimal control policy by using the **Hamiltonian analysis** and **PMP**(Pontryagin Maximum Principle) to solve the UAV data harvesting problem with a novel wireless sensor communication model.
- Applied **PSO**(Particle Swarm Optimization) to search optimal path and implemented **IPA**(Infinitesimal Perturbation Analysis) gradient descent to guarantee the convergence of optimization, which led to success of data harvesting for more than 5 sensors.
- Developed a **CLF-CBF** based tracking controller to ensure the safety at multi-agent data harvesting and solved the **Symmetric Deadlock** problem by adding control input perturbation, successfully controlled three quadrotors flying without collision.

Optical Flow Vision Sensing Control Model using Deep Reinforcement Learning

Boston, MA

BU Robotics Lab, Boston University

Dec. 2020 - Jun. 2021

- Built robot vision-based control model and set up **Reinforcement Learning** environment to train controller in **ROS**.
- Designed robot model with **PID controller** and equipped robot with a depth camera using **Lucas–Kanade** method to get optical flow data.
- Applied **Kalman filter** to decrease the sensing noise, and the controller achieve 87% average success rate in **Gazebo**.

Data Driven Robot Hand Grasping Posture Learning

New York, NY

Project in Robotics Studio, Columbia University

Feb. 2019 - May. 2019

- Contributed to robot hand grasping model based on **SVMs**(Support Vector Machines) model; identified the grasping posture data using ROS in Python and designed 3-D robot model on **Solid Works**.
- Used **Kernel K-mean** and apply **PCA** (Principal Component Analysis) to do decomposition for hand joints data. Achieving 97% accuracy of grasping label prediction.

Publications

[1] **Yancheng Zhu***, Sean B. Andersson. "A Fisher Information based Receding Horizon Control Method for Signal Strength Model Estimation", *The 2024 American Control Conference (ACC)*, 2024.

[2] Guoyao Shen*, **Yancheng Zhu**, et al. "MRI Field-transfer Reconstruction with Limited Data: Regularization by Neural Style Transfer", *arXiv preprint arXiv:2308.1096*, 2023.

[3] **Yancheng Zhu***, Sean B. Andersson. "Safety Guaranteed Optimal Control Policy for Multi-agent Data Harvesting using a CLF-CBF approach", *The 2023 American Control Conference (ACC)*, 2123-2128, 2023.

[4] Shili Wu*, **Yancheng Zhu**, et al. "Time Optimal Data Harvesting in Two Dimensions through Reinforcement Learning Without Engineered Reward Functions", *The 2023 American Control Conference (ACC)*, 1289-1294, 2023.

[5] **Yancheng Zhu***, Sean B. Andersson. "Control Policy Optimization for Data Harvesting in a Wireless Sensor Network", *Proc. IEEE Conference on Decision and Control (CDC)*, 7437–7442, 2022.

Volunteer Experience

BU Robotics Lab Tour

Presentation / Attendance

- Guide tour and run the research demos for visiting undergraduates and high school students

International Academic Conferences

Presentation / Attendance

- IEEE International Symposium on Multi-Robot & Multi-Agent Systems (MRS), Dec. 2023
- The 2023 American Control Conference (ACC), May. 2023

References

- Prof. Sean Andersson
  Ph. D, Professor, at Mechanical Engineering, Boston University, Boston, US
  (+1)617-353-4949 sanderss@bu.edu
- Prof. Hod Lipson
  Ph. D, Professor, at Mechanical Engineering, Columbia University, New York, US
  (+1)212-854-2966 hod.lipson@columbia.edu