Jiahe Chen

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RESEARCH PROFILE

I am interested in leveraging swarms of robots with minimal onboard capabilities combined with advanced mathematical models to develop scalable error-tolerant multi-robot systems capable of building large-scale complex structures. My research approach is influenced by multiple diverse fields, including collective intelligence, agent-based modeling, probability theory and stochastic processes, and optimal transport theory.

Research Focus: Robotic Construction, Multi-Agent Systems, Distributed Robotic Systems
Tools: Robot Operating System (ROS), Linux, AutoCAD, Altium, Cadence
Programming: Python, C, Verilog, MATLAB, Mathematica
ML Libraries: TensorFlow, PyTorch, OpenAI Gymnasium, Stable Baselines3, scikit-learn, statsmodels

EDUCATION

Cornell University *Sep 2019 - Dec 2024*

- **Degree:** Ph.D. in Electrical Engineering, GPA 3.82/4.0
- **Thesis:** Error-Tolerant Decentralized Robotic Construction
- **Committee:** Kirstin Petersen (Advisor), Nils Napp, Francesca Parise
- **Core Courses:** Multi-Agent Systems, Machine Learning, Data Mining, Network Systems and Game Theory, Probability Theory and Sochastic Processes, Reinforcement Learning

University of Pennsylvania *Sep 2017 - May 2019*

- **Degree:** M.S. in Electrical Engineering, GPA 3.97/4.0
- **Core Courses:** Analog Mixed-Signal and RF IC Design, Silicon Photonics, VLSI, Digital Signal Processing

Queen's University at Kingston *Sep 2013 - May 2017*

- **Degree:** B.S. in Engineering Physics, Minor in Electrical Engineering, First Class Honours
- **Core Courses:** Solid State Physics, Micro-Electromechanical Systems, Electromagnetic Theory, Thermodynamics, Quantum Mechanics, Mathematical Methods in Physics

PUBLICATIONS

1. **Jiahe Chen** and Kirstin Petersen, *Distributed Coordination of Simple Earthmover Robots for Terrain Modification*, under review in International Conference on Robotics and Automation (ICRA), 2025.
2. **Jiahe Chen** and Kirstin Petersen, *2D Construction Planning for Swarms of Simple Earthmover Robots*, International Symposium on Distributed Autonomous Robotic Systems (DARS), 2024.
3. Danna Ma, **Jiahe Chen**, Sadie Cutler, and Kirstin Petersen, *Smarticle 2.0: Design of Scalable, Entangled Smart Matter*, International Symposium on Distributed Autonomous Robotic Systems (DARS), 2022.
4. **Jiahe Chen** and Kirstin Petersen, *Decay-Based Error Correction in Collective Robotic Construction*, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2022.
5. **Jiahe Chen**, Yifang Liu, Adam Pacheck, Hadas Kress-Gazit, Nils Napp, and Kirstin Petersen, *Errors in Collective Robotic Construction*, International Symposium on Distributed Autonomous Robotic Systems (DARS), 2021.
6. Han Hao, **Jiahe Chen**, Andrew G. Richardson, Jan Van der Spiegel, and Firooz Aflatouni, *A 10.8 μW Neural Signal Recorder and Processor with Unsupervised Analog Classifier for Spike Sorting*, IEEE Transactions on Biomedical Circuits and Systems, 2021.

PROFESSIONAL SERVICES

Reviewer for RA-L and ICRA

Teaching Assistant for ECE 4160 Fast Robots (Cornell), ECE 2300 Digital Logic & Computer Organization (Cornell), ESE 568 Mixed Signal Design and Modeling (UPenn), ESE 570 Digital Integrated Circuits and VLSI-Fundamentals (UPenn)

Member of Cornell Computer Systems Laboratory Student Steering Committee in 2021-2022

AWARDS

Jacobs Fellowship (Cornell) *Aug 2020 & Aug 2021*
Merit-Based Fellowship (Cornell) *Aug 2019*
Outstanding Academic Award Honorable Mention (UPenn) *May 2019*
Dean's Scholar (Queen's) *May 2015 & May 2017*
Excellence Scholarship (Queen's) *Sep 2013*

PROJECTS

Collective Robotic Terrain Transformation [Link] *Mar 2022 - Dec 2024*
Advised by Prof. Kirstin Petersen, Cornell University

- Developed an error-tolerant distributed algorithm based on optimal transport theory to coordinate a swarm of minimalistic robots to build complex continuous terrains under motion noise and constraints.
- Developed a dynamical system model of the robot's interaction with granular material based on real data.
- Built a lightweight simulator in Python based on the proposed model that drastically reduces the computation time of simulating large-scale multi-robot construction with granular material.

Physics Simulation of Robotic Construction with Granules [Link] *Mar 2023 - Dec 2023*
Advised by Prof. Kirstin Petersen, Cornell University

- Built an agent-based physics simulator in Python to simulate multi-robot construction with granular material using Pymunk as the physics engine and Pygame for visualization.
- Developed a reinforcement learning training environment for the construction problem using OpenAI Gymnasium. Discovered optimal policies for several construction tasks using Stable Baselines3.

Collective Robotic Construction [Link] *Apr 2020 - Mar 2022*
Advised by Prof. Kirstin Petersen, Cornell University

- Built an agent-based simulator in Python to simulate multiple brick-carrying climbing robots that assemble a user-defined 3D structure at an arbitrary scale.
- Developed a distributed algorithm to resolve deadlocks in large-scale multi-robot construction.
- Developed a distributed error correction algorithm that utilizes stochastic decay processes performed by minimalistic robots to eliminate errors and ensure the long-term performance of large-scale construction.

Price Prediction of Used Cars [Github] *Sep 2021 - Dec 2021*
ORIE 5741 Learning with Big Messy Data, Cornell University

- Discovered the best price prediction method for used cars based on the market dataset of over 400,000 vehicles by training, testing, and comparing different machine learning models.

Multi-Robot Wireless Charging System [Link] *Sep 2019 - Jul 2020*
Advised by Prof. Kirstin Petersen, Cornell University

- Designed a low-cost programmable wireless power transfer system that can charge multiple modular robots in 6 hours with a high tolerance for coil misalignment and be easily manufactured.

Implantable Chips for Brain-Machine Interface Applications [Link] *Jan 2018 - Jun 2019*
Advised by Prof. Firooz Aflatouni and Prof. Jan Van der Spiegel, University of Pennsylvania

- Worked with a joint team of Penn Engineering and Penn Medicine to design an ultra-low-power implantable chip that uses machine learning to classify neural signals from human brains in real-time with high accuracy.
- Designed an implantable chip for safe neurostimulation treatment with minimum tissue damage.