

# 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 Languages:** Python, C, Verilog, MATLAB, Mathematica

## 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

### University of Pennsylvania

Sep 2017 - May 2019

- **Degree:** M.S. in Electrical Engineering, GPA 3.97/4.0

### Queen's University at Kingston

Sep 2013 - May 2017

- **Degree:** B.S. in Engineering Physics, Minor in Electrical Engineering, First Class Honours

## 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  $\mu$ W 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

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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

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**Collective Robotic Terrain Transformation** Mar 2022 - Present  
*Advised by Prof. Kirstin Petersen, Cornell University*

- Developed an error-tolerant distributed planning 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 Granular Material** 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** 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** 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** 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** 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.