Gerry Chen

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OVERVIEW

Generative embodied AI through a collaborative graffiti spray painting robot using diffusion models for robot action generation.
Expected graduation: May 2024 (Georgia Tech Robotics PhD)
Keywords: robot art, human-robot collaboration, computer vision, robotics, optimal control
Primary Languages: Python, C++

EDUCATION

Georgia Institute of Technology, *Ph.D. Robotics*   **08/2019 to Present**
School of Interactive Computing
> Studying human-robot collaboration through generative art under Frank Dellaert and Seth Hutchinson
> Thesis: Rendering, Replicating, and Adapting Human Motions on a Cable Robot for Artistic Painting
> 3.96/4.00 cumulative GPA

Georgia Institute of Technology, *M.S. Computer Science*   **08/2019 to 12/2022**
College of Computing
> 3.96/4.00 cumulative GPA

Duke University, *B.S.E. Electrical and Computer Engineering*   **08/2015 to 05/2019**
Pratt School of Engineering
> Electrical & Computer Engineering (major), Mechanical Engineering (major), CS (minor), Math (minor)
> 3.87/4.00 cumulative GPA, Magna Cum Laude

PUBLICATIONS

11. <u>G. Chen</u>, F. Dellaert, and S. Hutchinson, "Generalizing Trajectory Retiming to Quadratic Objective Functions", *IEEE International Conference on Robotics and Automation (ICRA)*. (2024). **Pending Review**

10. <u>G. Chen</u>, H. Muriki, C. Pradalier, Y. Chen, and F. Dellaert, "A Hybrid Cable-Driven Robot for Non-Destructive Leafy Plant Monitoring and Mass Estimation using Structure from Motion", *IEEE International Conference on Robotics and Automation (ICRA)*. p (2023).

9. Y. Zhang, F. Jiang, <u>G. Chen</u>, V. Agrawal, A. Rutkowski, and F. Dellaert, "Constraint Manifolds for Robotic Inference and Planning", *IEEE International Conference on Robotics and Automation (ICRA)*. p (2023).

8. <u>G. Chen</u>, S. Hutchinson, F. Dellaert, "Locally Optimal Estimation and Control of Cable Driven Parallel Robots using Time Varying Linear Quadratic Gaussian (LQG) Control", *2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. p (2022).

7. Y. Zhang, <u>G. Chen</u>, A. Rutkowski, F. Dellaert, "Efficient Range-Constrained Manifold Optimization with Application to Cooperative Navigation", *2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. p (2022).

6. <u>G. Chen</u>, S. Baek, J. Florez, W. Qian, S. Leigh, S. Hutchinson, and F. Dellaert, "GTGraffiti: Spray Painting Graffiti Art from Human Painting Motions with a Cable Driven Parallel Robot", *IEEE International Conference on Robotics and Automation (ICRA)*. p 3-19 (2022).

5. A. Cohen, <u>G. Chen</u>, E. Berger, S. Warrier, G. Lan, E. Grubert, F. Dellaert, Y. Chen, "Dynamically Controlled Environment Agriculture: Integrating Machine Learning and Mechanistic and Physiological Models for Sustainable Food Cultivation", *ACS ES&T Engineering*. p 3-19 (2022).

4. S. Yang, <u>G. Chen</u>, Y. Zhang, F. Dellaert, H. Choset, "Equality Constrained Linear Optimal Control With Factor Graphs", *2021 International Conference on Robotics and Automation (ICRA)*. p 9717-9723 (2021).

3. Z. Li, A. Yang, <u>G. Chen</u>, Z. Zeng, A. Peterchev, S. Goetz, "A High-Frequency Pulsating DC-Link for Electric Vehicle Drives with Reduced Losses", *47th Annual Conference of the IEEE Industrial Electronics Society (IECON)*. p 1-6 (2021).

2. P. Grady, <u>G. Chen</u>, S. Verma, A. Marellapudi, N. Hotz, "A Study of Energy Losses in the World's Most Fuel Efficient Vehicle", *IEEE Vehicle Power and Propulsion Conference (VPPC)*. p 1-6 (2019).

1. F. Wang*, <u>G. Chen</u>*, and K. Hauser, "Robot Button Pressing in Human Environments", *2018 IEEE International Conference on Robotics and Automation (ICRA)*. p 7173-7180 (2018).

SKILLS

- Diffusion Models, Embodied AI, Imitation Learning
- NeRF, 3D Reconstruction, Computer Vision
- State Estimation, SLAM, Optimal Control
- Strong command of Python, C++, and Matlab
- Proficiency in CUDA, PyTorch, HTML/CSS/JS
- Full-Stack Roboticist, Embedded, Hardware, ROS

HONORS AND AWARDS

Sigma Xi Honor Society   **08/2020 to Present**

Tau Beta Pi Honor Society – *NC Gamma Chapter*   **05/2019 to Present**

IEEE Eta Kappa Nu Honor Society – *Delta Lambda Chapter*   **01/2018 to Present**

Pi Tau Sigma Honor Society – *Pi Iota Chapter*   **01/2017 to Present**

GVU Foley Scholar   **10/2022**
Finalist

     Foley Scholars are the GVU Center's highest recognition for student research contributions to computing.

National Science Foundation Graduate Research Fellows Program   **03/2020**

Honorable Mention

     The NSF GRFP recognizes and supports outstanding graduate students in supported STEM disciplines.

Guinness World Records   **06/2019**

Most Efficient Prototype Electric Vehicle

     President of the Duke Electric Vehicles team that broke the record with 77.98Wh/100km.

Duke University Electrical and Computer Engineering Department   **05/2019**

Graduation with Departmental Distinction

     Presented for my distinguished research and academic record.

Guinness World Records   **07/2018**

Most Fuel-Efficient Vehicle

     Head of hydrogen fuel cell development for the record breaking fuel cell vehicle achieving 14,573MPGe.

RESEARCH EXPERIENCE

Robotics Estimation and Control   **08/2019 to Present**

Georgia Institute of Technology - Dr. Frank Dellaert

- Combined estimation and optimal control using factor graphs
- Cable driven parallel robot (CDPR) design and control

Robot Art   **08/2019 to Present**

Georgia Institute of Technology - Dr. Frank Dellaert & Dr. Seth Hutchinson

- Graffiti spray-painting robot based on a cable driven parallel robot (CDPR) design.
- Non-destructive plant analysis using structure-from-motion (SfM) and a cable-driven parallel robot.

Power Electronics   **08/2018 to 05/2019**

Duke University - Dr. Stefan Goetz and Dr. Angel Peterchev

- Implemented novel FOC motor controller using modular multilever series-parallel converter to self-balance battery cells, reduce noise, increase voltage ratings, and minimize losses
- Thermal analysis of battery/converter modules for use in automotive setting
- Electrical losses analysis for MOSFET selection in converter modules
- Installation of novel motor controller in electric vehicle to test practical cell-balancing performance

Fuel Cell Hybrid Vehicle   **08/2017 to 05/2018**

Duke University - Dr. Josiah Knight and Dr. Nico Hotz

- Optimization of fuel cell operating parameters for use in hybrid vehicle to achieve 58.9% in-system efficiency (increase from baseline efficiency of 40%)
- Design and optimization of voltage converter for active supercapacitor load power leveling system resulting in 22% higher vehicle efficiency
- See Publication 2 – fuel cell vehicle system level design

Robotics Motion Planning   **01/2017 to 05/2018**

Intelligent Motion Laboratory - Dr. Kris Hauser

- Applied convolution-based image similarity metrics for database assisted vehicle path planning
- Fabricated silicon and polyurethane cornea models with <50um repeatability for use in surgical robot testing
- See Publication 1 – work funded by NSF Research Experiences for Undergraduates (REU) to implement a Precision Positioning Unit (PPU) on the Tele-Robotic Intelligent Nursing Assistant (TRINA)

- Redundancy resolution for minimum manipulability / maximum continuous range joint configurations
- Fabricated polyurethane "finger" tip with integrated tactile sensor and 95.7% actuation success rate

WORK HISTORY

Computer Vision Intern
05/2023 to 08/2023

Verdant Robotics

- Prototyped (Jax) and implemented (CUDA) KLT Pose tracker to improve vehicle localization accuracy and robustness
- Implemented field-scale offline mapping / 3D reconstruction for farmer analytics and visualization
- Prototyped (GTSAM) passive auto-calibration of camera intrinsics and extrinsics to streamline manufacturing and improve accuracy under changing environmental conditions

Instructor
05/2022 to 08/2022

Georgia Institute of Technology

- **CS3630:** Intro to Perception & Robotics

Software Engineer Intern: Autonomous Vehicle Perception
05/2021 to 08/2021

Zoox - Dr. Subhasis Das

- Developed smoothing-based tracker for improved object tracking using sensor fusion
- My code achieved improvements in all tracking metrics for use in offline labeling, with 2 patents pending

Integrated Control and Estimation Intern
06/2020 to 08/2020

Air Force Research Laboratory (Eglin AFB) - Dr. Adam Rutkowski

- Refine collaborative vehicle control with imperfect multi-vehicle trajectory estimations
- Compute optimal sensor measurement timing and inter-vehicle communication
- Compute optimal collaborative trajectories to minimize navigation uncertainty using factor graphs

Controls Engineer Intern
05/2018 to 08/2018

Deka R&D - Dirk Van Der Merwe

- Developed novel 2-wheel balancing control scheme with constrained wheel displacement (patent pending)
- Created multi-system integration over CAN, EtherCAT, RS232 to create hybrid wheeled/legged robot
- Developed stability control of robot w/ powered casters + differential steering to test high speed dynamics

Robotics Motion Planning Intern
01/2017 to 05/2018

Intelligent Motion Laboratory - Dr. Kris Hauser

- Work on PPU for TRINA (see entry in Research Experience)
- Coded (Python, C++) and tested max. continuous range / min. manipulatability arm configurations

Teaching Assistant
08/2019 to 12/2019

Georgia Institute of Technology

- **CS3630:** Intro Perception & Robotics — Fall 2019

Teaching Assistant
08/2016 to 05/2018

Duke University

- **EGR201:** Mechanics of Statics — Fall 2017
- **ECE230:** Microelectronics — Fall 2017

- **ECE230:** Microelectronics — Summer 2017
- **EGR103:** Computational Methods in engineering — Fall 2016
- **CS201:** Data structures and Algorithms — Fall 2016

Tutor   **05/2014 to 05/2019**

Multiple Employers

- Duke Academic Resource Center - group instruction:
    - Multivariable Calculus — 08/2016 to 05/2019
    - Linear Algebra — 01/2017 to 01/2018
    - Differential Equations — 01/2017 to 01/2018
- Duke Academic Resource Center - individual instruction:
    - Multivariable Calculus — 08/2016 to 05/2017
    - Linear Algebra — 08/2016 to 05/2017
    - Differential Equations — 08/2016 to 05/2017
- America Reads America Counts at Duke — 08/2015 to 06/2016
    - Durham Public Schools
    - Math + Reading
- Kumon Math and Reading Center of Fox Chapel — 05/2014 to 08/2016
    - personalized curriculum generation for 40+ students
    - student performance evaluations

EXTRACURRICULAR ACTIVITIES

Co-President   **08/2015 to 08/2019**

Duke Electric Vehicles Team

- World Record (2019): World's most efficient electric vehicle - team president
- World Record (2018): World's most fuel efficient vehicle - head of hydrogen system
- Lead creation of a fully autonomous vehicle to allow the vehicle to follow a "total system energy" optimized path subject to physical control constraints
- Co-lead hydrogen fuel cell hybrid vehicle for 2018 to achieve 14,573 MPGe
- Design + Manufacture + Test the high power super-capacitor control board to increase vehicle efficiency by 22%
- Create an automated testing system resulting in fuel cell efficiency increase from 40% to 63%
- Design + Manufacture + Install the carbon fiber inserts to decrease weight and increase modularity
- 2018: 1st place H2, 1st place battery-electric (12,398 MPGe), Technical Innovation Award at the Shell Eco-Marathon Americas

CTO   **08/2018 to 05/2019**

Delta Band Inc. - deltatrainer.fit

- Designed all electrical systems of the strength training workout tracker watch based on machine learning
- Currently on 7th generation electrical boards (Dec 2018)
- Initiating small-scale (100 devices) manufacturing for beta-testing devices to be shipped Jan 2019

Project Lead   **01/2016 to 01/2018**

Solar Benches

- Lead technical, financial, and administrative aspcts of augmenting existing campus benches with solar powered night-time task lighting and laptop/phone chargers to raise enthusiasm for clean energy
- Installed 2 test benches on campus after passing safety inspection on an off-site prototype bench

RELEVANT COURSEWORK

Georgia Institute of Technology

- CS7643 - Deep Learning
- CS8803 - Probabilistic Graphical Models in Machine Learning
- CS7476 - Advanced Computer Vision
- CS8803 - Mobile Manipulation
- CS6601 - Artificial Intelligence
- ECE6553 - Optimal Control

Duke University

- CS520/MATH565 - Numerical Analysis
- MATH577 - Mathematical Modeling
- MATH216 - Linear Algebra and Diff. Equations
- MATH353 - Ordinary and Partial Diff. Equations
- ECE382/ME344 - Control Systems