Andrew Gusty
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OBJECTIVE

Motivated PhD applicant with interdisciplinary research experience in perturbation methods, control theory, and nonlinear PDEs. Interested in developing analytical, numerical, and control frameworks for PDE-governed systems, especially in regimes where closed-form solutions are intractable.

Research Interests: Nonlinear PDEs, perturbation methods, soliton theory, optimal control, and stability analysis.

EDUCATION

University of Colorado - Bachelor of Science, August 2022 - May 2026

- Double Major: Applied Mathematics and Computer Science
- GPA: 3.913
- Dean's List (all semesters); Engineering Honors Program; Horace M. Hale Esteemed Scholar; CU General Engineering Scholarship.
  Relevant Mathematics Coursework: Nonlinear Control Systems, Partial Differential Equations, Real Analysis, Complex Analysis, Matrix Methods, Differential Equations, Operations Research, Calculus I-III, Markov Processes, Discrete Mathematics, and Applied Probability
  Relevant Computer Science Coursework: Algorithms, Quantum Algorithms, Advanced Data Science, Theory of Computation, Programming Languages, Computer Systems, Software Development, Intro to AI, and Data Structures
  Fall 2025 Coursework: Numerical Methods and Scientific Computing, Stochastic Analysis for Finance, Machine Learning, and Software Ethics

PUBLICATIONS

Gusty, A., Scarborough, C., Arbelaiz, J., & Jensen, E. (2025). "Optimal control of soft-robotic crawlers subject to nonlinear friction: A perturbation analysis approach". *IEEE Control Systems Letters, 9,* 1556–1561. https://doi.org/10.1109/LCSYS.2025.3581875.

McCurdy, A, **Gusty, A**, Jensen, E. (2025). "A System Level Approach to LQR Control of the Diffusion Equation." Submitted to *American Control Conference 2026.* Preprint: https://doi.org/10.48550/arXiv.2510.05345.

PRESENTATIONS

Gusty, A.*, Scarborough, C., Arbelaiz, J., & Jensen, E. *Optimal control of soft-robotic crawlers subject to nonlinear friction: A perturbation analysis approach.* Accepted for presentation at the IEEE Conference on Decision and Control (CDC), Rio de Janeiro, Brazil, December, 2025.

Gusty, A.* & Shim, J.* *Criterion for Pattern Formation in planar interfaces of Reaction-Diffusion models of Bacterial Growth*. Accepted for presentation at Joint Mathematics Meetings, Washington D.C., USA, January, 2026.

Gusty, A.* *Optimal Actuation in a Peristaltic Crawler,* University of Colorado Summer Program for Undergraduate Research, Boulder, CO, USA, July, 2024.

*Indicates presenting author.

RESEARCH EXPERIENCE

University of California, Irvine, Department of Mathematics
Patterns and PDEs REU Summer 2025 Researcher, June 22–August 16, 2025
Advisor: Dr. Paul Carter

- Applied modern techniques in Geometric Singular Perturbation Theory, stability analysis, and differential equations to approximate traveling fronts and predict the formation of patterns in PDE models for bacterial growth and self-organization.
- Developed and optimized numerical solvers (Newton's method, Runge-Kutta) in MATLAB to solve for traveling fronts and simulate reaction-diffusion PDE systems.

University of Colorado, Department of Electrical Engineering
Undergraduate Research Fellow, June 2024 - Present
Advisors: Dr. Emily Jensen, Dr. Cody Scarborough, Dr. Fruzsina Agocs, and Dr. Elizabeth Bradley

Optimal Control of Soft-Bodied Robots:

- Used perturbation theory to reduce and solve a nonlinear wave equation governing the dynamics of soft-bodied, earthworm-like robots under realistic friction models.
- Formulated and solved an optimal control problem for soft-bodied crawling robots to optimize speed and efficiency.

Stochastic Diffusion Control:

- Collaborated with a PhD student to apply System-Level-Synthesis (SLS) techniques to optimal distributed control of the diffusion equation with noisy state measurements.
- Our work extends SLS methods to settings with continuous spatial domains and continuous, infinite-horizon time, and allows for constraints to be incorporated convexly.

Senior Thesis - Solitons in Nonlinear Transmission Lines (NLTLs):

- Using soliton theory and perturbation methods to reduce an infinite-order, nonlinear PDE to a tractable ODE model that describes the long-term behavior of pulses traveling on NLTLs.
- Building constrained optimization and numerical tools in MATLAB to optimize NLTLs for synthesizing High-Powered Microwave pulses useful in applications.

OTHER WORK EXPERIENCE

University of Colorado, Office of Information Technology
Assistant Linux System Administrator, June 2022 - Present
Supervisor: Todd Schaefer

- Worked on Linux Platform and DevOps team to manage CU's Linux-based server infrastructure. Developed code for automation of configuration management and deployment tasks (Python, Bash, Ruby).
- Gained experience writing production-quality, tested code in a collaborative environment with strong development standards.

SERVICE

Walk to Defeat ALS and LiveLikeLou Foundation Fundraising
Volunteer, 2023 - Present.

- Volunteered to set up, tear down, and provide logistical support for participants at the annual Walk to Defeat ALS in Denver, CO
- Volunteered at multiple fundraising events each semester with Phi Delta Theta Fraternity, which raised over $10,000 for ALS research during the 2023-2024 school year.

EXTRACURRICULAR EXPERIENCE

COMAP - Mathematical Contest in Modeling (February 2024)

- Internationally recognized undergraduate applied math competition that takes place over 4 days. Worked in a team of three to derive and implement a mathematical model for momentum in sports.
- Paper can be found at: COMAP Paper

CU Robotics Club (August 2022 - May 2023)

- Worked as software developer on the perception team. Responsible for configuring remote graphical interface to data storage server for image labeling, image labeling system, selection of image recognition model, and training of model

SELECTED COURSE PROJECTS

Nonlinear Controls - Sectorial Operators and Stability of Parabolic PDEs

- This paper was written as a final project for a graduate course in Nonlinear Controls (ECEN 5738). The paper is a technical overview of a generalization of stability analysis for ordinary differential equations to systems modeled by partial differential equations, using semigroup theory, operator theory, and Complex Analysis. A 25-minute lecture was delivered in-class to accompany the project notes.
- Paper: Nonlinear Project

Matrix Methods - Mean-Variance Portfolio Optimization

- Explored theory and implementation Mean-Variance Portfolio Optimization. Experimentally back-tested a contemporary method to reduce overfitting, improving model robustness.
- Paper: MVP Project

Complex Analysis - Overview of Airfoil Design

- Applied conformal mappings to model airfoil geometry and streamline airflow analysis. Delivered a 25-minute presentation to the class on the theory and applications.
- Paper: Complex Analysis Project

TECHNICAL SKILLS

Mathematics: Differential equations, Real Analysis, Complex Analysis, Linear Algebra, Control Theory, Perturbation Methods, Probability, Stochastic Processes
Programming Languages: Matlab, Python, C++, LaTeX, SQL, Scala
Software & Tools: Git, Linux, Keysight ADS, JAX, TensorFlow