Luke Phillips

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Research Interests

Vision-Based Robot Control & Agile Autonomous Systems
My research interests lie at the intersection of perception, control theory, and machine learning for autonomous robotics. I am particularly fascinated by enabling robots to achieve fluid, animal-like agility in unstructured environments through vision-based navigation and onboard computation. Specific areas of focus include:

- **Learning-Based Control for Agile Flight:** Developing reinforcement learning and imitation learning algorithms for high-speed drone navigation in complex environments
- **Visual-Inertial Perception:** Integrating computer vision with sensor fusion techniques for robust state estimation and obstacle avoidance
- **End-to-End Sensorimotor Policies:** Designing deep learning architectures that map visual inputs directly to control commands for real-time autonomous navigation

I am driven by the goal of creating autonomous systems that match or exceed biological capabilities in speed, adaptability, and robustness—moving beyond current limitations to enable robots that can truly navigate and interact with the world as living organisms do.

Education

University of Utah | Salt Lake City, UT | *May 2024*
Bachelor of Science in Physics (Computational Physics and Astronomy Emphasis)
Bachelor of Science in Applied Mathematics
Minor in Computer Science

- Cumulative GPA: 3.283/4.0
- Dean's List: Fall 2020, Fall 2021, Spring 2024

- GRE: Verbal 160, Quantitative 163, Analytical Writing 4.5

Weber State University | Ogden, UT | *April 2020*
Associate in Science

Research Experience

Undergraduate Research Assistant | *May 2023 – August 2023*
Department of Physics and Astronomy, University of Utah
Advisor: Dr. Kyle Dawson

- Analyzed massive spectral datasets from the Dark Energy Spectroscopic Instrument (DESI) project using Python libraries including Pandas
- Identified classification disagreements between DESI survey data and earlier astronomical surveys
- Utilized high-performance computing resources through the Department of Energy's National Energy Research Scientific Computing Center (NERSC)
- Developed proficiency in cosmological data analysis techniques and large-scale scientific computing workflows

Undergraduate Researcher | *Spring 2024*
Integrated Multiphysics Laboratory, Department of Mechanical Engineering, University of Utah
Advisor: Dr. Pania Newell

- Developed convolutional neural network to predict mechanical properties (Young's modulus and Poisson's ratio) of porous materials from cross-sectional images
- Generated training datasets through finite element analysis simulations
- Applied deep learning to materials science problems requiring integration of computational mechanics and computer vision

Undergraduate Researcher | *Spring 2023*
Department of Mathematics, University of Utah
Course: MATH 4800 - Undergraduate Research in Mathematics (Honors)

- Utilized numerical simulations to model income distributions using Geometric Brownian Motion
- Verified predicted income distribution matched that of UK statistics
- Awarded research scholarship for exceptional work in upper-division mathematics

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Teaching Experience

Education Volunteer (Professeur de Mathématiques) | *June 2024 – Present*
U.S. Peace Corps, Guinea

- Teaching 8th grade mathematics to three classes of 70+ students each in French (language learned in-country)
- Pioneered exercise-focused curriculum emphasizing problem-solving over rote memorization, transforming pedagogical approach for 200+ students
- Collaborated with school administration to end corporal punishment
- Currently building computer lab to provide students with access to modern educational technology
- Developed professional fluency in French while adapting to cross-cultural educational environment

Math Tutor | *August 2023 – May 2024*
Math Center, University of Utah

- Provided individualized instruction across undergraduate mathematics curriculum from college algebra through differential equations
- Graded assignments for Calculus II, Calculus III, and Partial Differential Equations courses
- Collaborated in high-intensity tutoring environment addressing students' most challenging problems

Tutor | *August 2021 – August 2023*
Learning Center, University of Utah

- Conducted 1-on-1 tutoring sessions in Mathematics, Computer Science, and Physics (15 hours/week)
- Redesigned and overhauled training program for incoming tutors to establish consistent, high-quality tutoring standards
- Earned College Reading and Learning Association (CRLA) Level 3 Tutor Certification

Learning Assistant | *August 2022 – May 2023*
Department of Physics and Astronomy, University of Utah

- Assisted in planning discussion and laboratory sections for introductory Electricity and Magnetism course
- Employed Socratic questioning techniques to guide students toward self-directed problem-solving
- Completed pedagogical training through SCI 5050: The Science of Learning

Technical Projects

Interactive Cart-Pole Control Tutorial | *2024 – Present*
Personal Project | *lukedphillips.com*

- Developing comprehensive web-based educational resource demonstrating cart-pole balancing through five distinct control approaches: PID control, LQR, reinforcement learning, neural networks, and trajectory optimization
- Implemented interactive simulations using PyDrake with complete mathematical derivations
- Compares advantages of control theory, optimization, and machine learning for robotics applications

Feynman's Ratchet and Pawl Thermodynamics Simulation | *Fall 2023*
Computing in Physics II (PHYS 5730)

- Built complete physics simulation from scratch replicating Feynman's thought experiment
- Demonstrated that work cannot be extracted when both chambers are at thermal equilibrium
- Created full animation visualizing thermodynamic processes and entropy dynamics

Image Denoising via Discrete Fourier Transform | *Fall 2023*
Numerical Analysis (MATH 5610)

- Implemented frequency-domain noise reduction algorithm for grayscale images
- Successfully removed salt-and-pepper noise by filtering high-frequency components

Neural Network Hash Function Exploration | *Spring 2024*
Data Management for Machine Learning (CS 4964)

- Replaced the hash function of a hash table with a single layer neural network in an effort to reduce collisions when filling table

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Leadership & Engineering Experience

Avionics Team Lead | *2021 – 2024*
CubeSat Club, University of Utah

- Led team in designing and constructing functional telemetry ground station with tracking capabilities for UHF satellite communication
- Integrated Arduino-controlled motors with signal analysis software for antenna positioning
- Authored technical documentation for telemetry system architecture

- Educated team members on antenna design principles and relevant RF physics

Vice President | *2021 – 2024*
Aerospace Club, University of Utah

- Designed, built, tested, and launched high-power rocket with N-class motor for Spaceport America Cup collegiate rocketry competition
- Placed 31st out of 250 teams in international competition
- Developed MATLAB trajectory integration program incorporating engine thrust profiles, meteorological data, and aerodynamic models to predict rocket landing points
- Organized project workflow into structured tasks with timeline management to meet competition deadlines

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Technical Skills

Programming Languages:

- **Advanced:** Python, Java, C#, SQL
- **Intermediate:** JavaScript, Julia, LaTeX
- **Developing:** C++, MATLAB

Libraries & Frameworks:

- **Scientific Computing:** NumPy, Pandas, Matplotlib, Drake/PyDrake
- **Machine Learning:** PyTorch
- **Web Development:** FastAPI, SocketIO, UVicorn, Next.js

Domain Expertise:

- Scientific computing and numerical methods
- Machine learning and deep learning
- Control theory and dynamics
- Computer vision and signal processing
- High-performance computing and distributed systems

Honors & Awards

- **Dean's List**, University of Utah (Fall 2020, Fall 2021, Spring 2024)

- **Governor's Scholarship**, State of Utah (2020) – Awarded to early college graduates earning associate degrees during high school
- **University Incentive Scholarship**, University of Utah (2020)
- **Undergraduate Research Scholarship**, University of Utah Mathematics Department (Spring 2023)

Additional Training & Certifications

- **College Reading and Learning Association (CRLA) Certified Tutor, Level 3**
- **SCI 5050: The Science of Learning** – Learning Assistant pedagogical training
- **Buddhist Monastic Training** | Suk Sawang Temple, Chiang Mai, Thailand | *July 2022*
  - Ordained as Buddhist monk in cultural immersion program
  - Practiced intensive meditation (4-5 hours daily) and studied contemplative practices

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Languages

- **English:** Native
- **French:** Professional working proficiency (developed through Peace Corps service)
- **Spanish:** Elementary proficiency (2 semesters college-level coursework)

Relevant Coursework

Mathematics: Linear Algebra, Differential Equations, Partial Differential Equations, Complex Variables, Foundations of Analysis I & II (Honors), Discrete Mathematics, Probability Theory, Numerical Analysis

Physics: Classical Mechanics, Electricity & Magnetism, Quantum Mechanics, Thermodynamics & Statistical Mechanics, Modern Physics, Computational Physics I & II

Computer Science: Object-Oriented Programming, Algorithms & Data Structures, Scientific Computing, Software Practice, Data Management for Machine Learning

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References available upon request