Spencer Powers

Curriculum Vitae

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Education

2021 – 2023 **Master of Science in Engineering in Robotics** (GPA: **3.97/4.00**)
Johns Hopkins University, Baltimore.

2016 – 2021 **Bachelor of Science in Aerospace Engineering** (GPA: **3.95/4.00**)
University of Southern California, Los Angeles.
Minor in Statistics

Skills

Programming Languages: Python, C++

Tools and Frameworks: Robot Operating System 2 (ROS2)

Professional Experience

06/23 – Present **Robotics Engineer**
Pronto.ai, San Francisco, CA.

- Owned the path planning stack for all autonomous trucks across all mine sites
  - Upgraded trajectory generation capabilities to enable fleet deployment at challenging mine sites that were previously infeasible
  - Architected and implemented pipeline speed and reliability improvements, reducing average planning time by >90% and achieving >99% system uptime in production
  - Implemented robust trajectory optimization to enable faster truck cycle time

05/22 – 08/22 **Robotics Intern**
Pronto.ai, San Francisco, CA.

- Developed the company's first path planning stack for autonomous mining haul trucks
  - Designed and implemented trajectory generation solvers and related infrastructure
  - Drafted and executed test plans to rapidly iterate the software stack
  - Deployed the planner in production at a mine site by the end of the summer

06/19 – 08/19 **Summer Intern**
Department of the Army, Washington, D.C..

- Wrote software to conduct initial research analysis of systems for surveillance satellites
- Evaluated advanced concepts for satellite systems and provided recommendations to focus the efforts of a multi-million dollar R&D portfolio

05/18 – 12/18 **Development Engineering Intern**
ABL Space Systems, Los Angeles, CA.

- Designed the first gas generator and a main injector for the E2 engine
- Led in-house CNC machining of the first launch vehicle primary structure components

Research Experience

Rocket Propulsion

08/19 – 05/21 **Technical Advisor**

The Advanced Spacecraft Propulsion and Energy (ASPEN) Laboratory, University of Southern California, Los Angeles.

Student-led research group focused on nuclear propulsion and power for spacecraft. Faculty advisors: Dr. Charles Radovich, Dr. Paul Giuliano, Dr. Matthew Gilpin.

- Interfaced with new lab leads to ensure steady and focused progress on all research projects
- Spearheaded technical recruitment efforts, grew lab from 9 initial members to 31 after first recruitment cycle

05/18 – 08/19 **Co-Founder, Lab Co-Lead**

The Advanced Spacecraft Propulsion and Energy (ASPEN) Laboratory, University of Southern California, Los Angeles.

Student-led research group focused on nuclear propulsion and power for spacecraft. Faculty advisors: Dr. Charles Radovich, Dr. Paul Giuliano, Dr. Matthew Gilpin.

- Led development of electromagnetically-coupled computational fluid dynamics (CFD) models of the first Hyperion-1 test article using ANSYS Maxwell and Fluent
- Developed CAD models of the Hyperion-1 test articles for simulation and manufacturing
  - NERVA-type inductively heated metallic core using GN2 as the working fluid
- Presented original research at a conference within the first 7 months of the lab's inception
- Designed the Hyperion-1 test campaign, created master Gantt chart to guide development
- Developed engine sizing sheet that was used for preliminary feasibility studies

11/16 – 05/18 **General Engineer**

Liquid Propulsion Laboratory, University of Southern California, Los Angeles.

Graduate-level lab designing, building, and testing bi-propellant liquid rocket engines.

- Led ignition system development for the first successful hot fire of the Blue Steel (GOX/Kerosene) engine

Neural Computation and Neuromorphic Computing

12/19 – 05/21 **Remote Undergraduate Research Assistant**

The Berry Lab, Princeton Neuroscience Institute, Princeton University, Princeton.

The Berry Lab (PI: Dr. Michael J. Berry II) investigates how thousands of neurons connected in local microcircuits combine to carry out novel and powerful computations in the retina.

- Developed a Python codebase to investigate the fit behavior of an EM-based algorithm for fitting a latent variable model to the activity of a population of spiking neurons
- Investigated neuron population size thresholds for effective unsupervised learning of clusters of population responses from spike train data
- Optimized this custom codebase to run on the PNI computational cluster

08/20 – 11/20 **Undergraduate Researcher**

Department of Aerospace and Mechanical Engineering, University of Southern California, Los Angeles.

AME 490 (Advisor: Dr. Guillermo Reyes Souto) is focused on the development of an original research topic devised by the student.

- Implemented the SuperSpike learning algorithm for multilayer spiking neural networks to learn the time evolution operator of the heat equation from data alone
- Leveraged the Auryn library to simulate the SNN for training, wrote software to generate modal coefficients and to convert them to spike raster representation for training data

05/20 – 08/20 **Undergraduate Researcher**
Department of Physics and Astronomy, University of Southern California, Los Angeles.
PHYS 760 (Instructor: Dr. Satish Kumar Thittamaranahalli) is a PhD-level course focused on the development of an original research topic devised by the student.

- Built Python code base to independently reproduce results of "Memristive nanowires exhibit small-world connectivity" by Pantone et al. from Rain Neuromorphics (2018).
- Extended network topology analysis by estimating the topological dimension of the modeled neuromorphic chip architecture.

Presentations, Publications, and Research Reports

2020 Samantha Cendro, Trey Cranney, Spencer Powers, Connor Powers, Branden Kretschmer, Diego Ochoa-Cota, Micah Pratt. "Simulation and Experimental Validation of an Inductively Heated Solid-Core Nuclear Thermal Rocket Model." *2020 AIAA Propulsion and Energy Forum.*

2020 Spencer Powers. "Investigating the Topological Dimension of a Novel Manufacturing Method for Neuromorphic Hardware". *Report submitted for PHYS 760 research project.*

2019 Connor Powers, Spencer Powers, Samantha Cendro, Diego Ochoa-Cota, Branden Kretschmer. "Development Campaign for an Additively Manufactured, Inductively Heated Model of a Solid-Core Nuclear Thermal Rocket Engine". *Oral presentation at the 2019 Nuclear and Emerging Technologies for Space (NETS) Conference.*

2019 Spencer Powers, Connor Powers, Trey Cranney, Sam Cendro, Diego Ochoa-Cota, Branden Kretschmer, Kristen Pederson, David Amaral. "Development Campaign of an Additively Manufactured, Inductively Heated Model of a Solid-Core Nuclear Thermal Rocket Engine." *Poster presentation at the 2019 USC Undergraduate Symposium for Scholarly and Creative Work [Honorable Mention in the Physical Sciences, Math, and Engineering category].*

Honors and Awards

2021 Viterbi Community Impact Award

2021 2^{nd} Place, AIAA Region VI Student Conference Team Category
Regional student project competition. Project title: "A Novel Staged Warm Gas Thruster for CubeSats".

2016 - 2021 Viterbi Fellow
Highly selective group of incoming students with access to research funding

2016 - 2021 W.V.T. Rusch Undergraduate Engineering Honors Program

2016 - 2020 Presidential Scholarship
Four-year, half-tuition merit scholarship

2018 Tau Beta Pi Engineering Honor Society

2016 Merit Research Scholar
Awards funding for select students to work in faculty labs

Selected Coursework

EN.530.603 – **Applied Optimal Control**
Optimal control of dynamical systems subject to constraints and uncertainty. Topics include nonlinear optimization, calculus of variations, dynamic programming, linear quadratic (Gaussian) control, numerical trajectory optimization, optimal estimation (e.g. Kalman filtering, batch estimation), stochastic control.

EN.530.678 – **Nonlinear Planning and Control in Robotics**
Covers selected topics related to model-based trajectory planning and feedback control. Focus is on applications to robotic systems modeled as underactuated mechanical systems subject to constraints such as obstacles in the environment. Topics include nonlinear stability, controllability, stabilization, trajectory tracking, systems with symmetries, differential flatness, backstepping, probabilistic roadmaps, stochastic optimization.

EN.601.663 – **Algorithms for Sensor-Based Robotics**
Surveys the development of robotic systems for navigating in an environment from an algorithmic perspective. Topics include rigid body motion and kinematics, configuration space concepts, potential field and sampling-based path planning, localization with Kalman, Bayes, and particle filters, and SLAM. It will describe these concepts in the context of the ROS software system.

EN.520.637 – **Foundations of Reinforcement Learning**
Topics include model-based methods such as deterministic and stochastic dynamic programming, possibly LQR and LQG control, as well as model- free methods that are broadly identified as Reinforcement Learning. In particular, we will cover on and off-policy tabular methods such as Monte Carlo, Temporal Differences, n-step bootstrapping, as well as approximate solution methods, including on- and off-policy approximation, policy gradient methods, including Deep Q-Learning.

EN.530.624 – **Dynamics of Robots and Spacecraft**
Focused on Lagrangian mechanics with applications to robot and spacecraft dynamics and control. Topics include rigid body kinematics, efficient formulation of equations of motion by using Lagrange's equations, solutions of equations of motion, Hamilton's principle, and introduction to stability and control theory.

Miscellaneous Projects

08/20 – 11/20 **A Novel Staged Warm Gas Thruster for CubeSats**
This project was developed for AME 441 (Senior Projects Laboratory).
Cold gas thrusters are a popular propulsion method for CubeSats due to their simplicity and reliability, but their performance is poor compared to combustive and electric propulsion alternatives. Warm gas thrusters add a heating element to this architecture to improve the thruster efficiency, but existing heating techniques are either inefficient or needlessly complex. A new warm gas thruster design is introduced that builds upon the VACCO MiPS, an industry standard cold gas propulsion module, while outperforming CHIPS, an industry-standard resistojet warm gas thruster. An ideal in-space design was produced by integrating progressively more complex thermal analysis tools with thruster performance calculations to produce an optimized 1U configuration capable of delivering 478 N-sec of impulse in periodic 40 mN-sec blowdowns. This represents a 90% gain in delivered impulse over the MiPS, enabling the same complex formation-flying missions as CHIPS with 80% less heater power. The staged, cyclic nature of the proposed system is designed to meet temporal inter-maneuver requirements of FIONA, a modern formation flying algorithm used in the CanX-4 and CanX-5 Cubesat missions. A brassboard system was then designed to test key thruster behavior in a thermally analogous laboratory environment.