Carlos Morales

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EDUCATION

University of Washington | Seattle, WA — September 2024 – June 2027
Master of Science in Aeronautics and Astronautics, Studying Optimal Guidance and Control Theory

- GPA: 3.93 / 4.00
- Lab: UW Autonomous Controls Laboratory, PI: Behçet Açikmeşe

Purdue University | West Lafayette, IN — August 2020 - May 2024
Bachelor of Science in Mechanical Engineering

- GPA: 3.80 / 4.00

EXPERIENCE

UW Autonomous Controls Laboratory – Hypersonic Reentry Guidance, *Graduate Researcher* — September 2025 – Present

- Researching autotuned SCP-based reentry guidance with continuous-time constraints satisfaction (CTCS) to ensure satisfaction of critical mission constraints, including heat rate, dynamic pressure, and vehicle loads
- Implementing CTCS with autotuning to achieve robust performance without cumbersome hand-tuning of hyperparameters
- Building a Python framework for general hypersonic reentry modeling and trajectory optimization using high-fidelity 6-DoF aerodynamic lookup tables (LUT) obtained from Computational Fluid Dynamics (CFD)
- Building accurate LUT-based atmospheric modeling using the Mars Global Reference Atmospheric Model (Mars-GRAM)

NASA HLS Guidance and Controls – SCP Landing Guidance, *Intern* — August 2025 – Present

- Developed and implemented a Sequential Convex Programming (SCP) landing guidance algorithm for HLS
- Leveraged problem sparsity to reduce solve times from one minute to three seconds compared to previous implementations
- Used CVXPYGEN to generate flight-ready C-code using the ECOS solver for convex subproblem solutions
- Improved solve times to allow for novel SCP implementation into a high-fidelity 6-DoF precision landing simulation to evaluate algorithm performance and reliability

NASA HLS Trajectory Analysis – Landing Guidance and Ascent Trajectory Analysis, *Intern* — June 2025 – August 2025

- Developed a custom off-nominal powered descent landing guidance algorithm via convex Second-Order Cone Programming (SOCP) and a novel modeling approach for improved divert capabilities
- Formulated the landing problem using a surrogate 5-DoF model to improve algorithm performance while still capturing the coupled nature between translational and rotational dynamics, allowing for an increase
- Interfaced Copernicus trajectory optimization software with POST2 to simulate offboard correction maneuver computations
- Developed a 6-DoF visualization tool for analyzing trajectories from high-fidelity 6-DoF POST2 simulations

Eli Lilly Automation and Controls, *Intern* — May 2023 – August 2023

- Designed and implemented a fluid dynamic automatic control system for a reactor unit used to showcase Lilly's advancements in their proprietary methods for siRNA synthesis
- Programmed a PLC system to perform controlled siRNA synthesis sequences for synthetic molecule design and development

PROJECTS | https://carlosmgnc.github.io/

Sequential Convex Programming for Real-Time 6-DoF Powered Descent Guidance — December 2024 – January 2025

- Implemented a successive convex optimization algorithm to solve the 6-DOF powered descent guidance problem
- Leveraged the efficiency of interior point methods with CVXPY to enable iterative nonconvex trajectory optimization
- Developed a generalized SCP codebase for fast modeling and evaluation of algorithmic modifications
- Ran Monte Carlos to validate trajectory feasibility across a large range of initial conditions and atmospheric disturbances

Quadratic Program Solver — April 2025 – May 2025

- Built a C++ implementation of the CVXGEN Quadratic Program (QP) solver used in the Falcon 9 landing algorithm
- Leveraged the Eigen library to implement the primal-dual interior point method using Mehrotra predictor-corrector steps for computing search directions and iterative refinement to achieve accurate solutions to the KKT system

Active Controlled Model Rocket — April 2024 – September 2024

- Successfully designed, manufactured, launched, and recovered a model rocket with active attitude control on ascent
- Developed a 6-DOF aerodynamic flight control simulation in MATLAB and Simulink to tune control parameters
- Created a quaternion-based attitude estimation algorithm using integrated gyro measurements in C++
- Designed and built custom actuators to control aft fins used to aerodynamically stabilize the rocket's yaw, pitch, and roll

LEADERSHIP

VEX Competitive Robotics, Controls Lead and Mechanical System Designer — August 2016 – December 2022

- Led an interdisciplinary robotics team for over 4 years, culminating in divisional 1st place at the World Championship
- Developed autonomous motion control algorithms in C++ using PID, wheel odometry, and motion profiling

TECHNICAL SKILLS & RELEVANT COURSEWORK

- **Skills:** Python, MATLAB, Simulink, C++, Git, Copernicus, POST2, CVXPY, CVX, Convex Programming, Trajectory Optimization, Kalman Filtering, Creo, SOLIDWORKS, NX, Embedded Electronics, Arduino, Laser Cutting, 3D Printing, Soldering
- **Relevant Coursework:** Convex Optimization, Linear Systems Theory, Multivariable Control, State Estimation and Kalman Filtering, Aeroelasticity, Introduction to Computational Fluid Dynamics