Bogac Canbaz

531.510.2752 | Lincoln, NE 68512 | bogaccanbaz@gmail.com | LinkedIn Profile | Google Scholar Profile

Controls Engineer

Optimal Control and Trajectory Optimization | Nonlinear and Robust Control | Dynamic Modeling and State Estimation | Simulation to Hardware Validation | Real-Time C/C++ Deployment

PhD candidate in Electrical Engineering (University of Nebraska-Lincoln, expected December 2026) who designs optimal and nonlinear control algorithms from first principles and proves them on hardware under hard real-time constraints. Built the first real-time control stack in the literature for an underactuated four-DOF, two-actuator double-gimbal control moment gyroscope, where an adaptive LQR law that cleared every simulation check diverged on the rig near the gimbal-lock singularity, and the constrained nonlinear redesign cut settling time from 3.02 s to 0.94 s, a 69% reduction, at 0.12 degrees tracking RMSE. Owns the full path from deriving dynamics and formulating cost and constraint terms to deploying generated C code on real-time targets and defining the gates a controller clears before it touches the platform. Drawn to autonomy teams where controls is the layer that turns planned intent into precise, comfortable, and safe motion.

PROFESSIONAL EXPERIENCE

Ph.D. Graduate Research Assistant, Optimal Control, Estimation, and Real-Time Autonomy — **Sept. 2022 to Present**
University of Nebraska-Lincoln, Dept. of Electrical and Computer Engineering, Lincoln, NE

- Faced with no real-time implementation in the literature for an underactuated four-DOF, two-actuator double-gimbal control moment gyroscope, derived the full nonlinear dynamics, built the high-fidelity plant model and control stack in MATLAB/Simulink, and deployed generated C code to a Quanser QUARC real-time target, delivering the first hardware-validated stack for this class of system with cascaded torque and velocity loops holding a hard sampling and latency budget.
- Designed an adaptive LQR regulator for the rig, then traced an instability that appeared only on hardware: the law cleared every linear-region stability check yet diverged near the gimbal-lock singularity. Root-caused it against measured rig data and redesigned it as adaptive sliding mode control with barrier Lyapunov functions enforcing state constraints under model uncertainty, cutting settling time from 3.02 s to 0.94 s, a 69% reduction, at 0.12 degrees tracking RMSE.
- Needing torque and velocity states no sensor measured directly, characterized the actuator and sensing chain with mechanical and electrical colleagues, fused encoder and current-sensor telemetry into an observer-based estimator, and added a physics-informed neural network observer in PyTorch with the dynamics embedded in the training loss, cutting tracking error by 9.87% and control energy by 4.95% against the model-based baseline.
- Owning verification with no prior test precedent for the platform, defined acceptance metrics for settling time, tracking RMSE, and control energy, scripted simulation and hardware-in-the-loop campaigns across edge cases, singular configurations, and disturbance rejection as gates a controller cleared before earning rig time, and analyzed run telemetry in Python to catch regressions.
- Analyzed failure modes across the mechanical, electrical, and software stack and embedded protective limits and fault handling into the control logic, keeping a high-speed platform inside safe bounds across hundreds of hardware runs with no equipment damage, while directing three junior engineers on test design and instrumentation.
- Extended the work to trajectory-level manipulator control by modeling and controlling a Franka Emika Panda seven-DOF arm in NVIDIA Isaac Sim and Isaac Lab, with randomized scenario tests that screened controller robustness before hardware time was spent.

M.S. Graduate Research Assistant, Multiphysics Modeling and Numerical Optimization — **Aug. 2022 to May 2024**
University of Nebraska-Lincoln, Dept. of Electrical and Computer Engineering, Lincoln, NE

- Tasked with predicting thermal limits of high-frequency press-pack SiC FET inverter modules before prototypes existed, built electro-thermal multiphysics finite-element models in ANSYS and COMSOL, ran design-of-experiments and particle-swarm optimization sweeps across geometry and material choices, and converted the limits into protective logic that held hardware inside its safe operating envelope.
- Coordinated with electrical, mechanical, and systems engineers on inverter and motor-driver trade-offs, instrumentation, and test planning across prototype iterations, and applied FMEA per MIL-STD-883 to prioritize design changes, producing work that supported two IEEE ECCE papers and two co-invented U.S. patent applications published in February 2026.

Graduate Teaching Assistant, Embedded Systems and Technical Mentoring — **Aug. 2021 to Aug. 2022**
University of Nebraska-Lincoln, Dept. of Electrical and Computer Engineering, Lincoln, NE

- Guided students through embedded design projects involving hardware interfaces, real-time timing constraints, and on-target debugging, coaching a structured root-cause approach that measurably shortened the time teams needed to isolate faults.
- Translated timing, interfacing, and real-time systems concepts for students with mixed technical backgrounds, sharpening the cross-audience communication that hardware-software collaboration depends on.

CORE COMPETENCIES

- **Optimal Control and Trajectory Optimization:** LQR and adaptive LQR design, constrained optimal control with barrier Lyapunov functions, cost and constraint formulation under actuator and state limits, particle-swarm numerical optimization; model predictive control, online trajectory optimization, and collision-aware motion planning familiar and actively deepening.

- **Feedback Control Theory and Algorithm Design:** classical PID and cascaded loops, loop shaping with gain and phase margins, state-space and modern multivariable control, nonlinear and robust control via adaptive sliding mode, active disturbance rejection, observer-based control of underactuated systems.
- **Dynamic Modeling and Simulation:** first-principles derivation of nonlinear multi-body dynamics, high-fidelity plant and functional models in MATLAB/Simulink and Python, model validation against measured hardware data, NVIDIA Isaac Sim and Isaac Lab; vehicle dynamics, MuJoCo, and Drake familiar and actively deepening.
- **State Estimation and Sensor Fusion:** observer design, encoder and current-sensor fusion for torque and state estimation, filtering under noise and model uncertainty, physics-informed neural network observers in PyTorch.
- **Software and Real-Time Implementation:** Python and MATLAB/Simulink (advanced), C/C++ (working proficiency, actively strengthening for production codebases), code-generation-oriented C deployment to hard real-time targets (Quanser QUARC, Q8-USB DAQ), Git version control; ROS 2, large distributed codebases, and CI-driven automated testing familiar and actively deepening.
- **Verification, Validation, and Root-Cause Analysis:** test plans across the full operating envelope, simulation and hardware-in-the-loop validation gates, failure mode analysis, FMEA per MIL-STD-883, protective constraint enforcement in control logic, root-cause investigation of behavior that appears only on hardware, regression detection from run telemetry across hundreds of instrumented runs; ISO 26262 and IEC 61508 familiar and actively deepening.
- **Actuator and Motor Control:** cascaded torque and velocity loops for high-speed multi-DOF actuators, actuator characterization, linear current amplifiers, SiC inverter and motor-driver background; field-oriented control familiar and actively deepening.
- **Technical Leadership and Cross-Functional Collaboration:** technical direction of three junior engineers, work with mechanical, electrical, and systems engineers on characterization, instrumentation, and design trade-offs, design write-ups and technical reviews, five IEEE publications and two patent applications.

EDUCATION

PhD in Electrical Engineering, expected Dec. 2026
University of Nebraska-Lincoln, Lincoln, NE | GPA: 3.87/4.00

MS in Electrical Engineering, May 2024
University of Nebraska-Lincoln, Lincoln, NE | GPA: 4.00/4.00

BS in Electrical and Electronic Engineering, July 2021
Bogazici University, Istanbul, Turkiye | GPA: 3.00/4.00

AWARDS AND HONORS

- Graduate Scholarship, University of Nebraska-Lincoln, 2022 to 2026.
- College of Engineering Professional Development Fellowship, University of Nebraska-Lincoln, 2024.
- Holling Fellowship, University of Nebraska-Lincoln, 2021 to 2022.
- TUBITAK 2209-A Undergraduate Research Grant, 2021.

SELECTED PUBLICATIONS AND PATENTS

- B. Canbaz, W. Qiao, and L. Qu, "Finite-Time Adaptive Sliding-Mode-Based Control for Underactuated Double-Gimbal Control Moment Gyroscopes: Design and Experimental Validation," IEEE Transactions on Industrial Electronics, under review.
- B. Canbaz, L. Qu, and W. Qiao, "Adaptive Linear Quadratic Regulator Based Stabilizing Control for Underactuated Double Gimbal Control Moment Gyroscopes," IEEE Transactions on Industry Applications.
- B. Canbaz, W. Qiao, and L. Qu, "Adaptive Sliding Mode Control for Underactuated Double Gimbal Control Moment Gyroscope," 2025 16th IEEE International Conference on Industry Applications (INDUSCON).
- B. Canbaz, W. Qiao, and L. Qu, "Adaptive LQR Control of Underactuated Double Gimbal Control Moment Gyroscope," IEEE/IAS 61st Industrial and Commercial Power Systems Technical Conference (ICPS), Phoenix, AZ, Oct. 2024.
- B. Canbaz, E. Muravleva, J. Wang, L. Qu, and J. Hudgins, "Design and Optimization of a Novel Monolithic Spring for High Frequency Press Pack SiC FET Modules," 2023 IEEE Energy Conversion Congress and Exposition (ECCE), Nashville, TN, USA, 2023, pp. 5551 to 5557.
- E. Muravleva, B. Canbaz, J. Wang, L. Qu, and J. Hudgins, "Switch Cell Design for Novel High Frequency Press Pack SiC FET Modules," 2023 IEEE Energy Conversion Congress and Exposition (ECCE), Nashville, TN, USA, 2023, pp. 5455 to 5461.
- J. Wang, E. Muravleva, B. Canbaz, and L. Qu, "High Frequency Press Pack SiC FET Modules," published U.S. patent application US 2026/0039294 A1, February 2026, patent pending.
- J. Wang, B. Canbaz, E. Muravleva, and L. Qu, "Monolithic Spring Assemblies for High Frequency Press Pack Modules," published U.S. patent application US 2026/0036180 A1, February 2026, patent pending.