

ALEXANDER ELIAS

Ph.D. in Robotics, Rensselaer Polytechnic Institute · Member, IEEE

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- Creator of IK-Geo, an open-source inverse kinematics solver used by **NASA** and universities worldwide and cited on **Wikipedia**
- Versatile roboticist: From robot arms to mobile robots, foundational theory to real implementation, and academia to NASA/industry
- Skilled communicator and mentor with an eye for design and a knack for simplifying tough concepts
- Experienced in ROS(2), MoveIt, Python, C, C++, Rust, MATLAB, JavaScript/Node.js, HTML, CSS, Docker, GitHub, STM32, AI/ML
- Professional bassist (opened for Kevin Bacon), freelance graphic designer (40+ posters), and freelance lighting designer (30+ productions)

EDUCATION

Rensselaer Polytechnic Institute, Troy, NY

Ph.D. in Robotics, Department of Electrical, Computer, and Systems Engineering
GPA: **3.97/4.00**

Fall 2019–Summer 2025

Dual B.S. in Electrical Engineering and Computer & Systems Engineering, Minor in Economics
GPA: **3.97/4.00**; *Summa Cum Laude*; Dean's Honors List; Rensselaer Leadership Award

Fall 2015–Spring 2019

WORK EXPERIENCE

University of Kassel

Independent Robotics Consultant

August 2025–Present

Kassel, Hesse, Germany (Remote)

- Built production-grade C++ IK-Geo solver for ABB GoFa, integrating with Grasshopper Robot Components for visual robot programming

Draper

Instrumentation Electronics 8-Month Co-op

January–August 2018

Cambridge, MA

- Modeled and analyzed mixed-signal sensors (gyroscope, accelerometer, atomic magnetometer, and A/D converter), driving design decisions
- Developed solar-powered drone: designed test hardware/code, co-developed drone hardware and autonomous flight code
- Designed and built ultra-low-current picoamp-precision test jig, requiring clean room fabrication

GRADUATE RESEARCH EXPERIENCE

Ph.D. Research on Cuspidality, Redundancy, and Parallel Mechanisms (TA-funded)

Spring 2025–August 2025

- Discovered ABB GoFa is cuspidal (switches IK solutions without singularity). Proposed cuspidal planning/optimization methods.
- Analyzed redundancy parameterization, new singularities, IK, and cuspidality for ABB Yumi. (First redundant cuspidality results.)
- Extended IK-Geo to support efficient inverse and forward kinematics for parallel robots, including those with prismatic joints

NASA Goddard On-Orbit Satellite Servicing (OSAM-1)

Fall 2021–Fall 2024

- Designed 7-DOF space robot algorithms: compliance control, trajectory tracking, stability analysis, optimal control, dynamics modeling
- Developed IK-Geo: Solver finds all IK solutions for any robot and the fastest solver in our testing. (**40–200x faster** IK for UR5 than IKFast.)
- Proposed the stereographic SEW angle to enlarge the singularity-free workspace of 7R arms, which is especially useful for teleoperation

Multi-Robot Systems for Tent Manufacturing (ARM-TEC-20-02-F-15)

Summer 2020–Spring 2022

- Led development of 5 mobile robots (**2 custom robots**) for collaborative manipulation of heavy fabrics: PID control, ROS integration, wireless teach pendant, and constraint-aware formation control via QP optimization, enabling rigid-body formations with obstacle avoidance
- Implemented UWB localization and EKF sensor fusion with ± 5 cm accuracy, including antenna calibration and height constraints
- Demonstrated safe and reliable coordinated multi-robot manipulation for fabric transport, collaborative RF welding, and caging of large carts

RTX Robotic Deep Rolling (ARM-TEC-18-01-F-03)

Summer 2019–Spring 2020

- Designed motion-force control GUI for ABB robot: custom toolpaths, $\pm 5\%$ force accuracy, experimentally validated residual stress
- Designed and validated robot models from data: open-loop physical dynamics, inner closed-loop controller behavior (delay + low-pass filter), and outer-loop compliance models (joint and environment stiffness), enabling offline controller tuning

SELECTED PUBLICATIONS

A. J. Elias and J. T. Wen, “IK-Geo: Unified robot inverse kinematics using subproblem decomposition,”
Mech. Mach. Theory, vol. 209, Jul. 2025, Art. no. 105971.

A. J. Elias and J. T. Wen, “Redundancy parameterization and inverse kinematics of 7-DOF revolute manipulators,”
Mech. Mach. Theory, vol. 204, Dec. 2024, Art. no. 105824.