Zachary Yoder

PhD student - Max Planck Institute for Intelligent Systems

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Education

Ph.D. in Engineering Science, *University of Stuttgart, Stuttgart, Germany* 2021 - present
Research carried out at the Max Planck Institute for Intelligent Systems
Advisor: Dr. Christoph Keplinger

M.Sc. in Mechanical Engineering, *University of Colorado, Boulder, CO* 2019-2021
GPA: 3.94/4.00
Advisor: Dr. Christoph Keplinger

B.Sc. in Mechanical Engineering, *University of Pittsburgh, Pittsburgh, PA* 2015-2019
Minor in Computer Science
GPA: 3.79/4.00

Research Interests

Electrostatic transducers, HASEL actuators, soft robotics, reconfigurable robotics, capacitive sensing, haptic feedback, wearable devices, flexible electronics, high-voltage electronics

Professional Experience

Doctoral Research Assistant, *Max Planck Institute for Intelligent Systems, Stuttgart, Germany* 2021 - present
Robotic Materials Department

- Leveraged an emergent class of electrostatic transducers (HASEL actuators) for performant robotic systems.
- Created high-speed and high-strain robotic modules that use magnets to quickly connect together. Developed compact, snap-on, untethered high-voltage driving electronics.
- Introduced a class of wearable haptic devices powered by electrohydraulic actuators. Developed MATLAB interface for psychophysical study. Devised robust high-voltage safety scheme.
- Designed multi-material soft bending actuators used for gripping objects. Leveraged impedance spectroscopy to measure the capacitance of the actuators under application of high-voltage. Created algorithms which use capacitance feedback for pick verification and object size estimation.
- Developed test control and data acquisition interfaces in MATLAB to evaluate actuation and sensing behavior of soft transducers. Made programs widely accessible, resulting in adoption by 40+ team members across 10+ projects.

Graduate Research Assistant, *University of Colorado, Boulder, CO* 2019 - 2021
Keplinger Research Group

- Designed, fabricated, and evaluated a class of high-speed prosthetic fingers driven by electrostatic artificial muscles. Modeled the 4-bar kinematic finger linkage and optimized geometric parameters for use with the artificial muscles.
- Collaborated with industry partners to develop high-strain artificial muscles.

Teaching Assistant, *University of Colorado, Boulder, CO* 2019 - 2020
Manufacturing Processes and Systems course

- Trained students in design for manufacturing, GD&T, engineering drawing creation, and life cycle analysis. Taught lab sessions, held office hours, graded assignments.

Undergraduate Research Assistant, *University of Pittsburgh, Pittsburgh, PA* 2018 - 2019
ZXY Intelligent Precision – Advanced Manufacturing (ZIP-AM) Laboratory

- Measured absorption spectra of photoresponsive polymers using FT-IR spectroscopy.

New Product Development Engineering Co-op, *MSA Safety, Pittsburgh, PA* 2017 - 2018
Supplied Air Respirators Department

- Designed components and executed validation testing for highly-regulated supplied air respirator products. Applied finite element analysis to inform design of mechanical parts. Assisted in product builds.

Journal Publications

[5] **Yoder, Z.**, Rumley, E. H., Schmidt, I., Rothemund, P., & Keplinger, C. (2024). *Hexagonal electrohydraulic modules for rapidly reconfigurable high-speed robots.* **Science Robotics.** 9, eadl3546.
DOI | Video | Project page

[4] Sanchez-Tamayo, N., **Yoder, Z.**, Rothemund, P., Ballardini, G., Keplinger, C., & Kuchenbecker, K. (2024). *Cutaneous Electrohydraulic (CUTE) Wearable Devices for Pleasant Broad-Bandwidth Haptic Cues.* **Advanced Science,** 2402461
DOI | Video | Project page

[3] Rumley, E. H., Preninger, D., Shagan Shomron, A., Rothemund, P., Hartmann, F., Baumgartner, M., Kellaris, N., Stojanovic, A., **Yoder, Z.**, Karrer, B., Keplinger, C., & Kaltenbrunner, M. (2023). *Biodegradable electrohydraulic actuators for sustainable soft robots.* **Science Advances,** *9*(12), eadf5551.
DOI | Video

[2] **Yoder, Z.**, Macari, D., Kleinwaks, G., Schmidt, I., Acome, E., & Keplinger, C. (2022). *A Soft, Fast and Versatile Electrohydraulic Gripper with Capacitive Object Size Detection.* **Advanced Functional Materials,** 2209080.
DOI | Video | Project page | Journal back cover

[1] **Yoder, Z.**, Kellaris, N., Chase-Markopoulou, C., Ricken, D., Mitchell, S. K., Emmett, M. B., Weir, R. F. f., Segil, J., & Keplinger, C. (2020). *Design of a High-Speed Prosthetic Finger Driven by Peano-HASEL Actuators.* **Frontiers in Robotics and AI,** *7*.
DOI | Project page

Awards

Best demo, EuroEAP 2024, *Hexagonal electrohydraulic (HEXEL) modules for rapidly reconfigurable high-speed robots.*

Best poster, IEEE Conference on Soft Robotics (Robosoft) 2024, Multi-modal Soft Robots Workshop, *Hexagonal electrohydraulic (HEXEL) modules for rapidly reconfigurable high-speed robots.*

Best poster, IEEE Conference on Soft Robotics (Robosoft) 2023, Soft Grippers Workshop, *A soft, fast, and versatile electrohydraulic gripper with capacitive object size detection.* Presented by Daniela Macari.

Best presentation, IROS 2022, 5th workshop on proximity perception, *Integrated actuation and sensing for a new class of electrohydraulic soft robotic grippers.*

Best presentation, Graduate engineering annual research and recruitment symposium (GEARRS), *Artificial muscles for the next generation of life-like robotics.*

Second place product pitch, Randall family big idea product innovation competition, *EnduroTracker*. $15,000 award.

Leadership, Mentoring and Service

Graduate Research Mentor, *Max Planck Institute for Intelligent Systems, Stuttgart, Germany* Fall 2023

- Mentored a Bachelor student's thesis on using machine learning to model the relationship between capacitance and displacement in soft grippers. Trained the student in scientific writing and presenting. Student's thesis earned an award.

Ph.D. Student Representative, *Max Planck Institute for Intelligent Systems, Stuttgart, Germany* 2023 - 2024

- Developed a peer mentoring program which matched junior and senior Ph.D. students.

Student Athletics Tutor, *University of Colorado, Boulder, CO* 2019 - 2021

- Physics I and II, Thermodynamics I and II, Mechanical Design courses

President, Pitt Club Triathlon, *University of Pittsburgh, Pittsburgh, PA* 2017 - 2018

- Grew membership 140%, increased budget 333% and tripled the number of yearly club races.

Freshman Engineering Leadership Team, *University of Pittsburgh, Pittsburgh, PA* 2017 - 2019

- Gave weekly presentations and tours to prospective engineering students and their families.

Peer Reviewer: Soft Robotics, ICRA, Living Machines conference

Conference Contributions

[6] IEEE Conference on Soft Robotics (RoboSoft), San Diego, USA. April 2024. *Cutaneous electrohydraulic (CUTE) wearable devices.* [Demonstration]

[5] IEEE Haptics Symposium, Long Beach, USA. April 2024. *Cutaneous electrohydraulic (CUTE) wearable devices.* [Demonstration]

[4] IEEE International Conference on Soft Robotics (Robosoft), Multi-Modal Soft Robots Workshop, Long Beach, USA. April 2024. *Hexagonal electrohydraulic (HEXEL) modules for rapidly reconfigurable high-speed robots.* [Poster presentation]

[3] International Conference on Soft Transducers and Electromechanically Active Polymers (EuroEAP), Bristol, UK. June 2023. *High-strain honeycomb-HASEL actuators for fast and reconfigurable robots.* [Poster presentation]

[2] Intelligent Robotics and Systems (IROS) Conference, 5th Workshop on Proximity Perception, Kyoto, Japan. October 2022. *Integrated actuation and sensing for a new class of electrohydraulic soft robotic grippers.* [Oral presentation]

[1] International Conference on Soft Transducers and Electromechanically Active Polymers (EuroEAP), Online Forum. June 2021. *Soft electrohydraulic actuators for a new generation of life-like prosthetic devices.* [Poster presentation]

Skills

Software: SolidWorks, OnShape, Adobe Premiere Pro, Affinity Designer, National Instruments, Microsoft Office

Programming languages: MATLAB, Python, Java

Prototyping: 3D printing, laser-cutting, high-voltage electronics, fixture design, screen and flexography printing

Actuator characterization: force-stroke behavior, specific energy and power, dynamics, power consumption, capacitive sensing

Materials characterization: electrochemical impedance spectroscopy, dielectric breakdown, tensile testing

Communication: presentations, demonstrations, product pitches