

Kaiwen Zuo

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EDUCATION

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- Case Western Reserve University (CWRU), Cleveland, USA
Ph.D. in Electrical Engineering Sep 2024 – Present
 - Case Western Reserve University (CWRU), Cleveland, USA
M.S. in Mechanical Engineering Sep 2022 – May 2024
 - Huazhong University of Science and Technology (HUST), Wuhan, China
B.Eng. in Mechanical Design, Manufacturing and Automation Sep 2018 – May 2022

PUBLICATIONS

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- [1] Kaiwen Zuo, Shuyuan Yang, and Zonghe Chua. “A Model-based Visual Contact Localization and Force Sensing System for Compliant Robotic Grippers”. In: *TBD* (2026). Under double-blinded review, PDF available upon request.
 - [2] Jianfeng Zhou, Jiaji Su, Kaiwen Zuo, Mingyu Pan, Zonghe Chua, and Kathryn A. Daltorio. “A High Load Density Miniature Force Sensor for Probing With Robot Feet”. In: *IEEE Robotics and Automation Letters* 11.1 (2025), pp. 450–457. ISSN: 2377-3766. doi: 10.1109/lra.2025.3632679.
 - [3] Jiaji Su, Kaiwen Zuo, and Zonghe Chua. “Three Degree-of-Freedom Soft Continuum Kinesthetic Haptic Display for Telemanipulation Via Sensory Substitution at the Finger”. In: *IEEE Conference on Telepresence*. 2024, pp. 79–86. doi: 10.1109/Telepresence63209.2024.10841502.

SELECTED PROJECTS

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- Project 1: Encounter Haptics for Nurse Training in Virtual Reality (Video Demo)** Oct 2025 - Nov 2025
Role: Lead Researcher, Advisor: Prof. Zonghe Chua, Location: ERIE Lab, CWRU
 - Developed a VR-based encounter haptics system using a Kinova 7-DOF robotic arm to provide realistic physical interaction and force feedback for immersive nurse training.
 - Designed and implemented a pose transformation algorithm to pre-estimate contact between the user and virtual objects, which was used to control a modified soft pad mounted on the robot end effector for haptic rendering.
 - Project 2: Model-based Visual Contact Localization & Force Sensing for Compliant Grippers*** May 2023 - May 2025
Role: Lead Researcher, Advisor: Prof. Zonghe Chua, Location: ERIE Lab, CWRU
 - Conducted research on vision-based contact localization and force sensing for passive compliant robotic end effectors, enabling dexterous manipulation under partial observability and occlusion.
 - Developed a novel image-based online mesh reconstruction pipeline to resolve scale mismatch between physical objects and learning-based predicted meshes, enabling accurate geometry-aware contact inference.
 - Designed a model-based iterative contact localization algorithm capable of pre-estimating contact regions and handling severely occluded contact locations during grasping.
 - Established experimental benchmarks, including static grasping tests and on-robot comparisons against an end-to-end data-driven baseline, to quantitatively evaluate force estimation accuracy and robustness.

Publication: *Under Double-blinded Review* [1]
 - Project 3: Soft Whole Finger Haptic Interface for Teleoperation** May 2023 - Nov 2024
Role: Collaborating Researcher, Advisor: Prof. Zonghe Chua, Location: ERIE Lab, CWRU
 - Contributed to the design of a grounded soft whole-finger haptic interface combining 3-DOF kinesthetic feedback and 1-DOF cutaneous feedback for teleoperated robotic manipulation.
 - Assisted in design and FEA simulations of soft actuators using hyperelastic material models (Mooney–Rivlin, Yeoh, Ogden) to inform actuator geometry and material selection.
 - Supported the design and fabrication of a closed-loop fluidic actuation and control system enabling compound pressure regulation across multiple air chambers.
 - Developed and constructed a benchtop experimental setup to evaluate path tracking accuracy and force output characteristics of the soft actuator.

Publication: *IEEE Conference on Telepresence 2024* [3]

ONGOING PROJECTS

Project 1: Differentiable Simulator for Soft Robotic End Effectors* (Primary) Role: Lead Researcher, Advisor: Prof. Zonghe Chua, Location: ERIE Lab, CWRU	May 2025 - Present
<ul style="list-style-type: none">Conducting research on the development of a differentiable physics simulator for deformable meshes to support design and analysis of soft robotic end effectors.Building extended position-based dynamics (XPBD) simulators to model large-deformation behavior of soft robotic end effectors, including fin-ray-shaped grippers.	
Project 2: A Clinically Deployable Desktop Indenter System (Secondary) Role: Lead Researcher, Advisor: Prof. Zonghe Chua, Location: ERIE Lab, CWRU	Sep 2025 - Present
<ul style="list-style-type: none">Investigating the clinical setup of a desktop indenter system (Clindent) to obtain in vivo creep loading curves from patient limbs, establishing a quantitative baseline for longitudinal assessment of tissue mechanical properties during recovery.Designed and fabricated a noninvasive, patient-friendly mechanical structure for the Clindent system, and integrated mechatronic components for data acquisition, I/O communication, and motor control.	
Project 3: Synergy-Based Force Signal Compression for Human In-Hand Manipulation (Secondary) Role: Lead Researcher, Advisor: Prof. Zonghe Chua, Location: ERIE Lab, CWRU	Sep 2025 - Present
<ul style="list-style-type: none">Implementing an in-hand-sized instrumented object embedded with three ATI force/torque sensors to capture multi-finger manipulation forces and investigate preliminary synergy-based force signal compression strategies.Designed, prototyped, and fabricated the in-hand-sized sensing object with integrated force/torque sensors, and developed a torque-based force transformation algorithm to collect finger manipulation forces without relying on motion capture systems.	

RELEVANT TECHNICAL SKILLS

Programming: Python (PyTorch, Taichi, OpenCV, Open3D), C++, MATLAB, Git.
Robotics & Simulation: ROS 2, SOFA, Abaqus, Finite Element Analysis (FEA), Extended Position-Based Dynamics (XPBD).
Mechanical Design & Fabrication: SolidWorks, Onshape, AutoCAD, 3D printing (FDM, SLA), soft robotic design and fabrication (origami-inspired pneumatic grippers, passive fin-ray-shaped grippers).
Control & Instrumentation: Closed-loop control, fluidic actuation systems, Arduino-based prototyping.
Machine Learning & Vision: Computer vision-focused machine learning, image-based geometry reconstruction.
Languages: English (professional working proficiency), Chinese (native proficiency).

RESEARCH MENTORSHIP

Sahasrakshi Dasika (Undergraduate) XPBD-based Force Estimation for Deformable Grippers	Sep 2025 - Present
<ul style="list-style-type: none">Mentored an undergraduate researcher on developing an XPBD-based physics simulation of a fin-ray-shaped soft gripper for force estimation.Provided guidance on simulation setup and contributed to the preparation of an academic research proposal.	
Hoang Nguyen (Undergraduate) A Clinically Deployable Desktop Indenter System (Clindent)	Sep 2025 - Present
<ul style="list-style-type: none">Mentored an undergraduate researcher on the design and construction of a clinically deployable desktop indenter system (Clindent) for in-vivo creep loading characterization.Provided technical guidance on device prototyping and contributed to the preparation of an academic research proposal.	
Juho Jeon (Undergraduate) Vision-based Force Estimation for Deformable Grippers	Apr 2024 - Aug 2024
<ul style="list-style-type: none">Mentored an undergraduate researcher on integrating a RealSense D405 camera into a vision-based force sensing system for deformable grippers.Provided guidance on experimental setup, system integration, and academic writing, contributing to a technical report and poster presentation.	

TEACHING:

Teaching Assistant , ECSE 246: Signals and Systems • Led recitation sessions and office hours and graded exams for a class of 75 students.	Sep 2025 - Dec 2025
Grader , EMAE 350 & EMAE 351	Sep 2023 - Dec 2023

LEADERSHIP & COMMUNITY SERVICE

Presenter , Human Fusion Institute Open House	Jun & October 2025
• Demonstrated a vision-based contact localization and force estimation system integrated with a pneumatic fingertip actuator to visiting high school students.	
Coordinator , ERIE Lab Tour	Jun 2025
• Coordinated and guided a lab tour for 24 Bay STEM Academy students.	
Reviewer , <i>IEEE Conference on Telepresence 2025</i>	May 2025
• Reviewed three conference submissions.	
Reviewer , <i>CWRU Undergraduate Research Summer Application</i>	Mar 2025
• Reviewed five research proposal applications.	
Student Volunteer , <i>IEEE Haptics Symposium 2024</i>	Apr 2024