

Kaiwen Zuo

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EDUCATION

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

PUBLICATIONS

- [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

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) May 2025 - Present

Role: Lead Researcher, Advisor: Prof. *Zonghe Chua*, Location: ERIE Lab, CWRU

- 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) Sep 2025 - Present

Role: Lead Researcher, Advisor: Prof. *Zonghe Chua*, Location: ERIE Lab, CWRU

- 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) Sep 2025 - Present

Role: Lead Researcher, Advisor: Prof. *Zonghe Chua*, Location: ERIE Lab, CWRU

- 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) Sep 2025 - Present

XPBD-based Force Estimation for Deformable Grippers

- 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) Sep 2025 - Present

Control Design for a Clinically Deployable Desktop Indenter System

- Mentored an undergraduate researcher in the design and implementation of a graphical user interface (GUI) for a clinically deployable desktop indenter system (Clindent), and in fine-tuning motor control strategies.
- Provided technical guidance on device prototyping and contributed to the preparation of an academic research proposal.

Juho Jeon (Undergraduate) Apr 2024 - Aug 2024

Vision-based Force Estimation for Deformable Grippers

- 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 Sep 2025 - Dec 2025

- Led recitation sessions and office hours and graded exams for a class of 75 students.

Grader, EMAE 350 & EMAE 351 Sep 2023 - Dec 2023

LEADERSHIP & COMMUNITY SERVICE

Presenter , Human Fusion Institute Open House	Jun & October 2025
<ul style="list-style-type: none">• 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
<ul style="list-style-type: none">• Coordinated and guided a lab tour for 24 Bay STEM Academy students.	
Reviewer , <i>IEEE Conference on Telepresence 2025</i>	May 2025
<ul style="list-style-type: none">• Reviewed three conference submissions.	
Reviewer , <i>CWRU Undergraduate Research Summer Application</i>	Mar 2025
<ul style="list-style-type: none">• Reviewed five research proposal applications.	
Student Volunteer , <i>IEEE Haptics Symposium 2024</i>	Apr 2024