Kaiwen Zuo

kxz365@case.edu | 216-612-9119 | cuberkk.github.io | OH, USA

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

(EMAE 350: Mechanical Engineering Analysis, EMAE 351: Control of Mechanical System)

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, *IEEE Conference on Telepresence 2025*   May 2025
- Reviewed three conference submissions.

Reviewer, *CWRU Undergraduate Research Summer Application*   Mar 2025
- Reviewed five research proposal applications.

Student Volunteer, *IEEE Haptics Symposium 2024*   Apr 2024