

Han Zhang

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EDUCATION

The Johns Hopkins University

Aug. 2022 – Dec. 2023

Master of Science; Biomedical Engineering

GPA: 3.80 / 4.0

Relevant course: Deep Learning, Computer Vision, Augmented Reality, Computer Integrated Surgery I&II, Medical Robot Design, Haptic Interface Design, Robot Device Kinematics Dynamics and Control, Algorithms for Sensor-based Robotics

University of California, Davis

Sept. 2018 – Jun. 2022

Bachelor of Science; Biomedical Engineering with Honors

GPA: 3.79 / 4.0

Relevant course: Data Structure, Biomedical Signal and Control, Biomedical Imaging System, Clinical Application of Biomedical Device Design, Biotransport Phenomena, Neuroengineering

RESEARCH EXPERIENCE

Spatial Planning for Medical Environment in Virtual Reality

July. 2023 – Present

Advisor: [Prof. Mathias Unberath](#)

ARCADE Lab, Johns Hopkins University

- Created digital twins using Neural Radiance Fields to improve spatial planning ability in operation room.
- Build a VR environment using Unity Engine for the surgical digital twin manipulation and user interaction.
- Set up a user study to investigate the mental impact of planning in different quality of OR reconstructions.

Autonomous X-ray Image Acquisition and Interpretation System

July. 2023 – Present

Advisor: Prof. Mathias Unberath

ARCADE Lab, Johns Hopkins University

- Aim to build autonomous robotic system to reduce excess X-ray acquisition for percutaneous fracture fixation.
- Developed a mixed reality interface using HoloLens 2 to enable the K-wire insertion dynamic real-time guidance and error calculation based on preoperative CT scan and intraoperative X-ray images.
- Implemented CT scan and patient registration using NDI tracking system to perform corridor interpretation.
- Designed and fabricated a surgical drill attachment using CAD enables reflective IR tracking and navigation.

Investigation on Engagement among Surgical Teams through Virtual Reality

Jun. 2023 – Sept. 2023

Advisor: Prof. Mathias Unberath

ARCADE Lab, Johns Hopkins University

- Investigated the cooperation and engagement in surgical teamwork using multiplayer virtual reality simulator.
- Developed the test scenarios for collaborative image-guided surgery using Unity Engine and ZMQ networking.
- Created a training curriculum and UI control panel for percutaneous pelvic fixation standard anatomical view.
- Set up a user study demonstrating that exposure to surgical workflows can also benefit non-surgical members.

Recreating Pelvic Trauma Surgery in Virtual Reality

Jan. 2023 – Jun. 2023

Advisor: [Prof. Russell H. Taylor](#) & Prof. Mathias Unberath

ARCADE Lab, Johns Hopkins University

- Led the development of a multiplayer VR simulator for pelvic trauma surgery for orthopedic surgeons training.
- Implemented C-arm fluoroscopy device positioning and virtual surgical instrument interactions in VR environment, utilizing real-time digitally reconstructed radiographs to generate simulated X-ray images.
- Created a realistic simulation using Raycasting algorithms to mimic the precise insertion of Kirschner-wires into human tissue, incorporated haptic feedback for a tactile experience mirroring real-world interactions.
- Utilized ZMQ networking to capture DRR snapshots data, multi-user synchronization, and objects pose information for replaying and further analysis.
- This work was present in JHU LCSR Industry Day and featured in [LINK Award](#).

Surgical Skill Assessment in XR Using Eye Tracking

Feb. 2023 - Jun. 2023

Advisor: [Prof. Ehsan Azimi](#)

Department of Computer Science, Johns Hopkins University

- Developed an augmented reality pipeline using C# to facilitate objective evaluation of trainee surgical skills.
- Implemented hand pose, eye gaze, and marker tracking utilizing Unity Engine and Vuforia Engine through HoloLens 2, enabling for generation of heat maps for in-depth gaze and skill analysis.
- Utilized MongoDB for efficient data storage and retrieval with automatic analysis workflow using Python.
- Conducted a pilot study to refine the methodologies and extract gaze features between naïve and expert.

Surgical Phase Recognition from X-ray Image

Jan. 2023 – Mar. 2023

Advisor: Prof. Mathias Unberath

ARCADE Lab, Johns Hopkins University

- Aim to create a surgical phase recognition model for X-ray-guided percutaneous pelvic fracture fixation based on AI-generated X-ray image.

- Conducted the cadaver study to verify the model effectiveness and performed the data analysis using Python.
- Created the 3D models of the surgical tools using Solidworks for realistic X-ray simulation.

3D Hapkit: 3-degree-of-freedom (DOF) Haptic Device

Jun. 2022 - Dec. 2022

Advisor: [Prof. Jeremy Brown](#)

Haptics and Medical Robotics Laboratory, Johns Hopkins University

- Used Solidworks to design and fabricate 3-DOF kinesthetic haptic device based on delta parallel mechanism.
- Utilized the Arduino and I2C protocol to achieve data communication and calculation of forward kinematics.
- Created a virtual environment using Processing library for rendering haptic interaction with virtual objects.

Radiolucent Hand and Wrist Fixation Device Senior Capstone Project

Sept. 2021- Jun. 2022

Advisor: [Prof. Robert M. Szabo](#)

Department of Orthopedics, UC Davis Health

- Designed and fabricated a device using Solidworks and rapid prototyping that stabilized patients' upper extremities during C-arm fluoroscopy to prevent surgeons' hands from radiation exposure.
- Created and optimized multiple designs using Finite Element Analysis to accommodate clinician need.
- Showcased as a model example for future students, highlighting exceptional design and documentation skills.

Low-Cost Microfluidic Device for Single-Cell Isolation and Cloning

Sept. 2021- Jun. 2022

Advisor: [Prof. Marc T. Facciotti](#)

BioInnovation Group at University of California, Davis

- Recruited and Lead 10 people to create cost-effective microfluidic chips for high throughput single cell isolation and culturing to analyze cell heterogeneity.
- Achieved the single cell capture rate to 35% at 1/100th the upfront cost using 3D printing techniques.

Automated Microscopy Drug Screening System for Cardiotoxicity Identification

Jan. 2021- Jun. 2022

Advisor: [Prof. Ye Chen-Izu](#)

Cardiac Signaling Laboratory at University of California, Davis

- Developed an innovative cell-in-gel chamber system with electric field stimulation using Solidworks.
- Analyzed flow and drug distribution of cell-in-gel chamber using FEA and fabricated by PDMS casting.
- Designed and fabricated adjustable stages used for Olympus Confocal Microscope by 3D printing.

PUBLICATIONS

- **H. Zhang** & B. D. Killeen (co-first authors), L. Wang, Z. Liu, R.H. Taylor, G. Osgood, and M. Unberath, Stand in My Shoes: Fostering Empathy and Engagement among Surgical Teams through Virtual Reality. *The 15th International Conference on Information Processing in Computer-Assisted Interventions*. In Review.
- C. Kleinbeck, **H. Zhang**, B. D. Killeen, D. Roth, M. Unberath, Optimizing Complex Medical Environments and Scenarios via Immersive Neural Rendering-based Digital Twins. *The 15th International Conference on Information Processing in Computer-Assisted Interventions*. In preparation.
- B. D. Killeen, **H. Zhang**, J. Mangulabnan, M. Armand, R.H. Taylor, G. Osgood, and M. Unberath, Pelphix: Surgical Phase Recognition from X-ray Images in Percutaneous Pelvic Fixation. *The 26th International Conference on Medical Image Computing and Computer-Assisted Intervention*. https://doi.org/10.1007/978-3-031-43996-4_13
- **H. Zhang**, J. U. Bartels and J. D. Brown, 3D Hapkit: A Low-Cost, Open-Source, 3-DOF Haptic Device Based on the Delta Parallel Mechanism. *2023 IEEE World Haptics Conference*, July 10-13, Delft, Netherlands.

PRESENTATIONS & DEMOS

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| ● IEEE World Haptics 2023 Conference, Delft, Netherlands | July 2023 |
| "3D Hapkit: 3-degree-of-freedom (DOF) Haptic Device using a Delta Parallel Mechanism" | |
| ● Johns Hopkins University LCSR Industry Day, Baltimore, USA | April 2023 |
| "PelvisVR: Recreating Pelvic Trauma Surgery in Virtual Reality" | |
| ● 2022 UC Davis College of Engineering Design Showcase, Davis, USA | June 2022 |
| "THF: Radiolucent Hand and Wrist Fixation Device For Intraoperative Fluoroscopy" | |

ACTIVITIES

Teaching Assistant, *Whiting School of Engineering, Johns Hopkins University*

Aug. 2023 - Present

- Haptic Interface Design for Human-Robot Interaction (EN 530.491/691).
- Intro to Augmented Reality (EN 601.454/654).

Team Leader in Microfluidics, *BioInnovation Group at University of California, Davis*

Sept. 2021 - Jun. 2022

Reviewer *International Conference on Information Processing in Computer-Assisted Intervention (IPCAI)*

2024

AWARDS

- Best Project Award in *Computer Integrated Surgery II, Johns Hopkins University*

May 2023

- Best Project Award *in Haptic Interface Design, Johns Hopkins University* Dec. 2022
- Excellence in Manufacturing Award *at Senior Design, University of California, Davis* Jun. 2022
- Dean's Honor List, *College of Engineering, University of California, Davis* Oct. 2021

TECHNICAL SKILLS

- **Programming Languages:** Python, MATLAB, C#, C++
- **Tools:** Unity, ROS, Arduino IDE, 3D Slicer, LaTeX, PyTorch, Git, Simulink
- **CAD Software:** Blender, Solidworks, 3DS Max
- **Manufacturing:** 3D Printing, CNC, Laser Cutting, Drilling, Welding
- **Wet Lab:** Cell Culture, 3D Bioprinting, Microscopy