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

Neural Digital Twins for Reconstructing Complex Medical Environments   July. 2023 – Present

Advisor: Prof. Mathias Unberath   *ARCADE Lab, Johns Hopkins University*

- Created 3D digital twins of complex medical environments and objects using Neural Surface Reconstruction.
- Built a VR environment using Unity3D for the surgical digital twin manipulation and user interaction.
- Set up a user study to reveal significantly increased perceived utility and presence using neural reconstruction-based environments, combined with higher perceived workload and exploratory behavior.

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 an augmented-reality system using Microsoft 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 Unity3D 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(DRR) to generate simulated X-ray images.
- Created a realistic simulation using custom algorithms to mimic the precise insertion of Kirschner-wires into human tissue, incorporated haptic feedback for a tactile experience mirroring real-world interactions.
- Utilized ZeroMQ networking to capture X-ray snapshots data, muti-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 Unity3D and Vuforia Engine through HoloLens 2, enabling generation of heat maps for in-depth gaze and skill analysis.
- Streamlined efficient data storage and retrieval with MangoDB to provide automatic analysis.
- 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.

PUBLICATIONS

- **H. Zhang** & B. D. Killeen **(**co-first authors**)** et al.: Stand in Surgeon's Shoes: Virtual Reality Cross-training to Enhance Teamwork in Surgery. *The 15th International Conference on Information Processing in Computer-Assisted Interventions*. In Review.
- C. Kleinbeck, **H. Zhang**, et al.: Neural Digital Twins: Reconstructing Complex Medical Environments for Spatial Planning in Virtual Reality. *The 15th International Conference on Information Processing in Computer-Assisted Interventions*. In Review.
- B. D. Killeen, **H. Zhang**, et al.: 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**, et al.: 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。

PRESENTATAIONS & DEMOS

- 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