

# YU-CHUN KU

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## EDUCATION

Johns Hopkins University, Baltimore, MD

Sep. 2022 – June 2024

Master of Science in Robotics

- **Selected Coursework:** Augmented Reality, Robot System Programming, Robot Device Kinematics Dynamics and Control, Algorithms for Sensor-based Robotics, Computer Integrated Surgery, Machine Perception

National Taiwan Normal University, Taipei, Taiwan

Sep. 2016 – June 2020

Bachelor of Mechatronic Engineering

- **Selected Coursework:** Machine Learning, Intelligent Automation and Robot, Artificial Intelligence

## RESEARCH INTERESTS

My research interests are creating intelligent computer-assisted systems that integrate **Digital Twins**, **Robotics**, and **Foundation Models** to transform healthcare and surgical interventions. I aim to: 1) develop high-fidelity digital twins that simulate surgical environments for optimizing workflows and supporting decision-making, 2) create intelligent robotic systems toward autonomous surgery, and 3) use foundation models to improve multimodal data processing, such as combining medical imaging and procedural knowledge to create intelligent systems.

## PUBLICATIONS

1. Y. Liu, **Y. Ku (co-first)**, J. Zhang, et al.: *dARt Vinci*: Egocentric Data Collection for Surgical Robot Learning at Scale. *The 2025 IEEE International Conference on Intelligent Robots and Systems*. In Review.
2. J. Wang, J. A. Barragan, H. Ishida, J. Guo, **Y. Ku**, et al.: [A Digital Twin for Telesurgery under Intermittent Communication](#). *The 2025 International Symposium on Medical Robotics*.
3. H. Zhang, B. D. Kileen, **Y. Ku**, et al.: [StraightTrack: A Mixed Reality Navigation System for Percutaneous K-wire Insertion](#). *Wiley Health Technology Letters*, 2024. *Special Issue: MICCAI AE-CAI 2024*.
4. **Y. Ku**, et al.: [Evaluating the Effectiveness of Visual Guidance for Out-of-View Object Localization using Mixed Reality Head-Mounted Displays](#). *Present as poster in The 23rd IEEE International Symposium on Mixed and Augmented Reality*.

## RESEARCH EXPERIENCE

[Mixed Reality Platform for Scalable Robotic Data Generation](#)

Dec. 2024 – Present

Isaac Sim, Unity3D, Robotics

Johns Hopkins University

- Designed an MR platform to enable teleoperation and scalable and high-quality ego-centric robotic data generation
- Integrated with NVIDIA Isaac Sim for realistic physics-based simulations and high-fidelity dataset creation
- Leveraged hand-tracking and inverse kinematics to enable real-time robot control and movement visualization
- Conducted a user study (12 participants, 10 tasks) comparing the MR platform to a real robot, showing a 41% increase in data throughput and a 10% reduction in experiment time.
- Findings submitted for review to **PUBLICATIONS #1**

**Room-Scale Digital Twin Simulation for OR Workflow Analysis**

Sep. 2024 – Nov. 2024

SAM2, Python, Digital Twins — **Advisor:** Prof. Mathias Unberath

Johns Hopkins University

- Creating object-level 3D digital twins of operating rooms for workflow analysis
- Generating annotated datasets of 14 instruments and 15 procedural phases to enhance instrument and phase detection
- Applying foundation models to extract features across 38 cases of video frames for accurate scene reconstruction
- Designed an annotation pipeline with a GUI for Segment Anything Model 2 to streamline segmentation and labeling

[Teleoperation with Communication Loss on da Vinci Surgical System](#)

Sep. 2024 – Nov. 2024

dVRK, ROS, Python — **Advisor:** Prof. Peter Kazanzides

Johns Hopkins University

- Developed a digital twin framework for the da Vinci surgical robot to maintain teleoperation functionality during communication loss using a virtual environment in the AMBF simulator
- Conducted a user study with 8 participants performing the peg transfer task 2 experimental conditions (baseline and replay), analyzing NASA TLX results to show reduced frustration and smoother task performance
- Revealed that the replay strategy reduced task completion time by 23% and improved workflow recovery
- Findings submitted for review to **PUBLICATIONS #2**

## High-Fidelity Virtual Reality Clinical Training System

June 2024 – Present

Unity3D, C#, Neuralangelo — **Advisor:** Prof. Vinciya Pandian & Prof. Mathias Unberath

Johns Hopkins University

- Developed a standalone VR system to simulate the central line dressing change procedure for clinical training
- Generated digital twin assets of medical environments and instruments using neural surface reconstruction techniques
- Implemented a sequential control mechanism to guide users through each procedural step accurately
- Designed a user study with healthcare professionals to evaluate the training effectiveness of the VR environment

## Mixed Reality-Assisted Trajectory Planning and Guidance System

June 2024 – Aug. 2024

Optical Tracking, 3D Printing — **Advisor:** Prof. Mathias Unberath

Johns Hopkins University

- Developed an MR system on HoloLens 2 for percutaneous orthopedic K-wire placement, achieving an average placement accuracy of 5.26 mm and 2.88°
- Integrated real-time instrument tracking and spatial alignment to minimize errors and improve insertion accuracy
- Collaborated with 2 experienced surgeons to evaluate system performance using custom 3D-printed phantom models
- Published findings in **PUBLICATIONS #3**

## Evaluating Effectiveness of Visualization Techniques in Mixed Reality

Sep. 2023 – Mar. 2024

User Study Design — **Advisor:** Prof. Alejandro Martin-Gomez

Johns Hopkins University

- Explored visualization methods to enhance localization of out-of-view objects on HoloLens 2, using Just Noticeable Difference (JND) to quantify perceptual thresholds
- Designed a user study with 24 participants, testing 3 MR techniques (3D Arrow, 3D Radar, EyeSee360) in 2 user interface modalities (dynamic, static)
- Revealed 3D Arrow as the most effective for rapid object identification, while 3D Radar and EyeSee360 offered distinct advantages in spatial encoding and panoramic awareness
- Published findings in **PUBLICATIONS #4**

## RELEVANT PROJECTS

### AI-Assisted Patient Navigation using Mixed Reality

Apr. 2024

RAG, LangChain — Healthcare Hackathon with AI (H2AI)

Georgetown University

- Built a virtual assistant for health providers and patients, enabling patient navigation using AI-embodied Mixed Reality
- Developed a device-agnostic, multi-agent, and MR-enabled system that provides remote clinical access, intuitive visualization, expert knowledge management, and online decision-making
- Built web scrapping components for actual local health provider data and expert knowledge

### Augmented Reality-Enhanced Surgical Microscopes for Spinal Procedures

Jan. 2024 – May 2024

Unity3D, C#, Python, NDI

Johns Hopkins University

- Developed an AR system using for real-time 3D anatomical visualization in Minimally Invasive Spinal Surgery
- Implemented real-time anatomy tracking and registration to digital twin using NDI tracking system
- Created a Unity plugin that enabled real-time marker-based detection and pose estimation using OpenCV

## WORKING & TEACHING EXPERIENCE

### Johns Hopkins University

Aug. 2023 – May 2024

Teaching Assistant, Augmented Reality

Baltimore, MD, USA

- Guided teams through advanced AR projects such as the development of a campus tour navigation system on mobile devices and surgical guidance interfaces for continuum manipulators

### DiJet Link Co., Ltd.

Sept. 2020 – May 2022

Full-Stack Software Engineer

Taipei, Taiwan

- Led the development of case management and reporting web platforms, phasing out paper-based systems by using PostgreSQL and Laravel PHP
- Designed and maintained robust databases, optimizing data schemas and reducing redundancies to enhance reporting and data processing workflows
- Developed dynamic front-end interfaces using Vue.js, improving user experience with reactive components and efficient two-way data binding
- Built a Node.js web system for monitoring underground water levels, incorporating time series data management and Python algorithms for precise data analysis

## TECHNICAL SKILLS

- **Programming Languages:** C++, C#, Python, MATLAB, JavaScript
- **Frameworks/Tools:** ROS, Unity3D, PyTorch, TensorFlow
- **Web Development:** Node.js, Express.js, Django, React, Vue.js, PostgreSQL, MongoDB