Benjamin D. Killeen

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Summary — A researcher in medical robotics, I strive to advance intelligent surgical systems to complement surgeons' technical knowledge with superhuman capabilities in image acquisition and surgical action. Outside of my research, I work to build community in my local network and professional societies, with the ultimate goal of fostering an inclusive environment for all.

Academic Experience

Research Assistant 08/2019 – now
Department of Computer Science, **Johns Hopkins University**
With Mathias Unberath, Gregory D. Hager.

Research Assistant 08/2019 – 06/2020
Laboratory for Computational Sensing and Robotics, **Johns Hopkins University**
With Gregory D. Hager, Mathias Unberath, and Russell Taylor.

Research Assistant 03/2018 – 08/2019
Department of Computer Science, **University of Chicago**
With Gordon Kindlmann.

Professional Experience

Computer Vision / AI Intern 06/2020 – 07/2020
Intuitive Surgical Inc., Applied Research
With Omid Mohareri.

Software Development Intern 06/2018 – 08/2018
Epic Systems, Cognitive Computing.

Research Intern 06/2017 – 08/2017
IBM Research - Almaden.
With Geoffrey Burr.

Education

Ph.D., Computer Science 08/2019 – now
Johns Hopkins University
With Mathias Unberath and Gregory D. Hager.

B.A. in Computer Science with Honors, Minor in Physics 09/2015 – 06/2019
University of Chicago
With Gordon Kindlmann.

Awards

Personal Awards

2. Recipient of the **Link Foundation Fellowship in Modeling, Simulation, and Training** 2023
The Link Foundation offers one year renewable fellowships for Ph.D.
Proposal: *Interactive Digital Twins for Simulating the Future of Work in AI- and Robot-assisted Operating Rooms*

1. **LCSR Fellowship for Outstanding Incoming Ph.D. Students** 2019

Publication Awards

4. Honorable Mention, **Bench-to-Bedside Award** 2023
For paper [J-5] at IPCAI 2023.

3. Runner Up, **Best Paper Award, Physics of Medical Imaging** 2022
For paper [C-5] at SPIE Medical Imaging 2022.

2. **Best Paper Award in Bioengineering** 2021
For paper [C-4] at IEEE BIBE 2021.

1. **Kaggle COVID-19 Dataset Award** 2020
For our US county-level dataset described in [M-1].

Class Awards

3. **Best Presentation Award** 2021
Reliable Software Systems, Johns Hopkins University.

2. **Best Graduate Project Award** 2020
Computer Integrated Surgical Systems and Technology II, Johns Hopkins University.

1. **Intuitive Surgical Best Project Award** 2019
Title: *Enriching Unsupervised Feature Learning via Intermediate Subtasks*
Deep Learning, Johns Hopkins University.

Services and Leadership

Societies

- **President** 08/2023 – now
LCSR Graduate Student Association (LCSR-GSA)

- **Sports Officer** 12/2021 – now
MICCAI Student Board (MSB)

- **Head of Student Resources** 09/2020 – 08/2022
LCSR Graduate Student Committee

Academic Services

- **Course Assistant** 2023
Future Faculty: Preparing a New Generation of PIs for the Academic Job Search
Department of Computer Science, Johns Hopkins University

- **Organizer** 2023
  Focus Group on Graduate Student Space
  Laboratory for Computational Sensing and Robotics, Johns Hopkins University

- **Brainlab Loop-X Trainer and Coordinator** 2022 – now
  Laboratory for Computational Sensing and Robotics, Johns Hopkins University

- **Robotorium and Mock OR Tours** 2022, 2023
  Laboratory for Computational Sensing and Robotics, Johns Hopkins University

- **Reviewer** 2022 – 2023
  MICCAI Educational Challenge

Journal Reviewer

- IEEE Transactions on Medical Imaging (TMI)
- Journal of Machine Learning Research (JMLR)
- Quantitative Imaging in Medicine and Surgery (QIMS)
- IEEE Robotics and Automation Letters (RA-L)
- Computer Assisted Surgery (CAI)
- Nature Scientific Data
- Medical Image Analysis (MedIA)

Conference Reviewer

- Medical Image Computing and Computer Assisted Interventions (MICCAI)
- International Conference on Information Processing in Computer-Assisted Interventions (IPCAI)
- International Symposium on Medical Robotics (ISMR)
- IEEE International Conference on Computer Vision (ICCV)
- IEEE/CVF Computer Vision and Pattern Recognition (CVPR)

Talks and Press

Invited Talks and Demos

4. medPhoton Invited Talk Series 06/2023
   medPhoton, Salzburg, Austria
   "Robotic X-ray Imaging Interfaces"

3. FDA DIDSR Seminar Series 05/2023
   Food and Drug Administration, Silver Spring, MD
   "Simulating Image-guided Interventions: Interactive Digital Twins to Usher in Next-generation Surgical Suites"

2. The Artificial Intelligence Society (HopAI) 04/2023
   Johns Hopkins University, Baltimore, MD
   "Yet Another Deep Learning Introduction for Everyone"

1. LCSR Seminar Series 04/2023
   Johns Hopkins University, Baltimore, MD

"An Autonomous X-ray Image Acquisition and Interpretation System for Assisting Percutaneous Pelvic Fracture Fixation"

Press

3. Our work [J-70] demonstrating the utility of synthetic data for training novel X-ray image analysis algorithms was featured in the JHU Engineering magazine, the JHU Hub, and Medical Xpress.

2. My proposal to the Link Fellowship on Simulation, Modeling, and Training was featured on the JHU Computer Science News.

1. Our work [C-3] demonstrating efficient strategies for training robots using reinforcement learning was featured in the JHU Hub, TechCrunch, Psychology Today, BBC News, and Voice of America.

Teaching

Computer Integrated Surgery II EN.601.456/656, Project Mentor
Johns Hopkins University
Spring 2023: *Recreating Pelvic Trauma Surgery in Virtual Reality for the Development of Novel C-arm Interfaces*
- Received **Best Project Award**

Spring 2023: *Making 2D/3D Registration Accessible*
Spring 2022: *3D Segmentation of Hard and Soft Tissue for Simulating X-ray Image Formation with Deep Learning*

Computer Integrated Surgery I EN.601.455/655, Teaching Assistant
Johns Hopkins University
Fall 2021, Fall 2022

Introduction to Computer Science CMSC 14100/14200, Course Assistant
Department of Computer Science, University of Chicago
Summer 2019

Machine Learning and Large Scale Data Analysis STAT 37601/CMSC 25025, Teaching Assistant
University of Chicago
Spring 2019

Scientific Visualization CMSC 23710, Course Assistant
Department of Computer Science, University of Chicago
Winter 2019

Supervision

As a member of the ARCADE Lab with Mathias Unberath, I supervise students' contributions to research. Where known, career steps after completing their research effort are provided.

Graduate

8. **Bohua Wan**, Johns Hopkins University 06/2023 – now

7. **Hengyu Cao**, Johns Hopkins University 08/2023 – now

6. **Shreayan Chaudhary**, Johns Hopkins University 05/2023 – now

5. **Han Zhang**, Johns Hopkins University 01/2023 – now

4. **Aditya Kulkarni**, Johns Hopkins University 09/2022 – now

3. **Qiyuan Wu**, Johns Hopkins University 08/2022 – 06/2023
   Qiyuan joined **Cornell University as a Ph.D. Student**.

2. **Zidi Tao**, Johns Hopkins University 10/2021 – 06/2022
   Zidi joined **Rensselaer Polytechnic Institute as a Ph.D. Student**.

1. **Shreaya Chakraborty**, Johns Hopkins University 08/2020 – 09/2021
   Shreya joined **PathAI as a Machine Learning Engineer**.

Undergraduates

6. **Darren Shih**, Johns Hopkins University 09/2023 – now

5. **Liam Wang**, Johns Hopkins University 01/2023 – now

4. **Sambhav Chordia**, Johns Hopkins University 06/2022 – 12/2022

3. **Sean Sebastian Darcy**, Johns Hopkins Univ 10/2021 – 10/2022
   Sean joined the **California Institute of Technology as a Ph.D. Student**.

2. **Nethra Venkatayogi**, Johns Hopkins University 05/2021 – 10/2021
   Visiting from the University of Texas at Austin
   Nethra joined **Johns Hopkins University as a Ph.D. Student**.

1. **Max Judish**, Johns Hopkins University 01/2021 – 08/2021
   Visiting from Brown University.

Publications

I have first/co-authored 7/4 peer-reviewed papers and 2/0 preprints. My publication list is also available on Google Scholar. (*) denotes equal contribution. I am an inventor on 2 patents or patent applications in process.

Peer-reviewed Journal Articles

J-6. **B.D. Killeen**, S.M. Cho, M. Armand, R.H. Taylor, M. Unberath. "In Silico Simulation: A Key Enabling Technology for Next-generation Intelligent Surgical Systems", *Progress in Biomedical Engineering*, 2023, vol. 5, no. 3, pp. 032001.
Invited submission to the *Special Issue on In Silico Trials.*

J-5. **B.D. Killeen**, C. Gao, K. Oguine, S. Darcy, M. Armand, R.H. Taylor, G. Osgood, M. Unberath. "An Autonomous X-ray Image Acquisition and Interpretation System for Assisting Percutaneous Pelvic Fracture Fixation", *International Journal of Computer Assisted Radiology and Surgery*, 2023.
Special Issue: *Information Processing in Computer-Assisted Interventions (IPCAI) 2023*
Awarded **Honorable Mention, Bench-to-Bedside Award** at IPCAI'23.

J-4. C. Gao, **B.D. Killeen**, Y. Hu, R. Grupp, R.H. Taylor, M. Armand, M. Unberath. "Synthetic Data Accelerates the Development of Generalizable Learning-based Algorithms for X-ray Image Analysis", *Nature Machine Intelligence*, 2023, vol. 5, no. 3, pp. 294-308.
Featured in the **JHU Hub**.
Featured in the **JHU News Letter**.
Featured in the **Nature Robotics and AI collection**.

J-3. **B.D. Killeen**, J. Winter, W. Gu, A. Martin-Gomez, R.H. Taylor, G. Osgood, M. Unberath. "Mixed Reality Interfaces for Achieving Desired Views with Robotic X-ray Systems", *Computer Methods in Biomechanics and Biomedical Engineering: Imaging & Visualization*, 2022.
Special Issue: *Augmented Environments for Computer Assisted Interventions (AE-CAI) 2020*

J-2. A. Hundt, **B.D. Killeen**, H. Kwon, C. Paxton, G.D. Hager. "'Good Robot!': Efficient Reinforcement Learning for Multi-Step Visual Tasks with Sim to Real Transfer", *IEEE Robotics and Automation Letters*, 2020, vol. 5, no. 4, pp. 6724-6731.

J-1. S. Ambrogio, P. Narayanan, H. Tsai, R. M. Shelby, I. Boybat, C. di Nolfo, S. Sidler, M. Giordano, M. Bodini, N. Farinha, **B.D. Killeen**, C. Cheng, Y. Jaoudi, G. W. Burr. "Equivalent-accuracy accelerated neural-network training using analogue memory", *Nature*, 2018, vol. 558, no. 7708, p. 60.

Peer-reviewed Conference Papers

C-6. **B.D. Killeen**, H. Zhang, J.E. Mangulabnan, M. Armand, R. Taylor, G.M. Osgood, **M. Unberath**. "Pelphix: Surgical Phase Recognition from X-ray Images in Percutaneous Pelvis Fixation", *Medical Image Computing and Computer Assisted Intervention (MICCAI)*, to appear 2023.

C-5. **B.D. Killeen**, S. Chakraborty, G. Osgood, **M. Unberath**. "Toward Perception-based Anticipation of Cortical Breach During K-wire Fixation of the Pelvis", *SPIE Medical Imaging*, 2022.
Selected for **oral** presentation.

C-4. J. Opfermann*, **B.D. Killeen***, C. Bailey, M. Khan, A. Uneri, K. Suzuki, M. Armand, F. Hui, A. Krieger†, M. Unberath†. "Feasibility of a Cannula-mounted Piezo Robot for Image-guided Vertebral Augmentation: Toward a Low Cost, Semi-autonomous Approach", *IEEE International Conference on BioInformatics and BioEngineering (BIBE)*, 2021.
* Joint first authors; † joint last authors.
Honored with a **Best Paper Award in Bioengineering**.

C-3. X. Liu*, **B.D. Killeen***, A. Sinha, M. Ishii, G. Hager, R. Taylor, M. Unberath. "Neighborhood Normalization for Robust Geometric Feature Learning", *IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, 2021, pp. 13049-13058.
* Joint first authors listed alphabetically.

C-2. C. Gao, X. Liu, W. Gu, **B.D. Killeen**, M. Armand, R. Taylor, M. Unberath. "Generalizing Spatial Transformers to Projective Geometry with Applications to 2D/3D Registration", *Medical Image Computing and Computer Assisted Intervention*, 2020, pp. 329-339.
Code available on **GitHub** here.

C-1. X. Liu[G+], Y. Zhang, **B.D. Killeen**, M. Ishii, G. Hager, R. Taylor, M. Unberath. "Extremely Dense Point Correspondences in Multi-view Stereo using a Learned Feature Descriptor", *IEEE Conference on Computer Vision and Pattern Recognition*, 2020, pp. 4847-4856.
Code available on **GitHub** here.

Preprints

M-2. J.Y. Wu*, **B.D. Killeen***, P. Nikutta, M. Thies, A. Zapaishchykova, S. Chakraborty, M. Unberath. "Changes in Reproductive Rate of SARS-CoV-2 Due to Non-pharmaceutical Interventions in 1,417 U.S. Counties", *medRxiv preprint*, 2020.

M-1. **B.D. Killeen**, J.Y. Wu, K. Shah, A. Zapaishchykova, P. Nikutta, A. Tamhane, S. Chakraborty, J. Wei, T. Gao, M. Thies, **M. Unberath**. "A County-level Dataset for Informing the United States' Response to COVID-19", *arXiv preprint*, 2020, arXiv:2004.00756.
The data described herein received a **Kaggle COVID-19 Dataset Award**.
Code available on **GitHub** here.

Patents

P-1. G.W. Burr, **B.D. Killeen**, "Efficient Processing of Convolutional Neural Network Layers Using Analog-memory-based Hardware. 20200117986, filed March 25, 2019, and issued April 16, 2020.

METADATA

This document was last updated on September 21, 2023.
An up-to-date version is available at `https://benjamindkilleen.com/files/cv_killeen.pdf`.