

Appointment

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Contents

| | |
|---|-----------|
| Appointment | 1 |
| Education | 3 |
| Research Experience | 3 |
| Teaching Experience | 4 |
| Course Instruction | 4 |
| Invited Course Lectures | 4 |
| Teaching Assistantship | 5 |
| Supervision/Mentoring Experience | 5 |
| Master's Students Supervised in Thesis/Project | 5 |
| Undergraduate Students Supervised in Honours Thesis/Project | 6 |
| Undergraduate Students Supervised in Research | 7 |
| Students Mentored in Research | 8 |
| Awards/Honours | 9 |
| Professional Activities | 10 |
| Conference Organization | 10 |
| Journal Article Reviews (ad hoc) | 11 |
| Conference Paper/Abstract Reviews (recurring) | 11 |
| Grant Proposal Peer Reviews (ad hoc) | 11 |
| Selected Outreach Activities | 11 |
| Invited Talks | 12 |
| Publications | 12 |
| Journal Articles | 12 |
| Conference Proceedings | 14 |
| Book Chapters | 16 |
| Presentations/Abstracts | 16 |
| Theses | 18 |
| Patents/Inventions | 18 |
| Funding | 19 |

Education

- 2014 - 2018 Doctor of Philosophy in Computing
Queen's University, Kingston, Canada
Thesis: Computer-Assisted Assessment and Feedback for Image-Guided Interventions Training
Supervisor: Gabor Fichtinger
- 2012 - 2014 Master of Science in Computing
Queen's University, Kingston, Canada
Thesis: Linear Object Registration for Image-Guided Interventions
Supervisor: Gabor Fichtinger
- 2008 - 2012 Bachelor of Science Honors in Applied Mathematics and Physics
Western University, London, Canada
Thesis: Surgical Workflow Segmentation of Ultrasound-Guided Epidural Procedures
Supervisor: Terry Peters

Research Experience

- 2024 - Associate Professor
Carleton University, Ottawa, Canada
Surgical Data Science
- 2019 - 2024 Assistant Professor
Carleton University, Ottawa, Canada
Surgical Data Science
- 2018 - 2019 Postdoctoral Fellow
Johns Hopkins University, Baltimore, USA
Modelling and Analysis of Surgical Performance in Septoplasty
- 2012 - 2018 Graduate Research Assistant
Queen's University, Kingston, Canada
Performance Analysis and Monitoring in Image-Guided Interventions
- 2015 - 2016 Visiting Researcher
University of Rennes 1, Rennes, France
Computer-Assisted Training for Deep Brain Stimulation and Surgical Ontologies
- 2011 Undergraduate Research Assistant
Queen's University, Kingston, Canada
Performance Analysis and Monitoring in Image-Guided Interventions
- 2010 Undergraduate Research Assistant
Queen's University, Kingston, Canada
Simulation of Surface Acoustic Wave Propagation and Phononic Crystal Etching

2008 - 2012 Scholar's Electives Researcher
Western University, London, Canada
Projects related to applied mathematics, physics, and computer science

Teaching Experience

Course Instruction

Winter 2025, COMP 4107: Neural Networks
Winter 2024, Carleton University, Ottawa, Canada
Winter 2023,

Fall 2024, COMP 3106/4106: Artificial Intelligence
Fall 2023, Carleton University, Ottawa, Canada
Fall 2022,
Fall 2021,
Winter 2021,

Winter 2025, COMP 5900: Surgical Data Science
Winter 2024, Carleton University, Ottawa, Canada
Winter 2023,
Summ 2022,
Fall 2020,
Winter 2020,

Winter 2021 COMP 2804: Discrete Structures II
Carleton University, Ottawa, Canada

Fall 2016 CISC 203: Discrete Mathematics for Computer Science II
Queen's University, Kingston, Canada

Invited Course Lectures

Winter 2024, HLTH 4102: New Health Technologies
Fall 2022, Carleton University, Ottawa, Canada
Fall 2021, Topic: Machine Learning in Surgery

Winter 2021, DATA 5000: Introduction to Data Science
Winter 2020, Carleton University, Ottawa, Canada
Topic: Surgical Data Science

Winter 2018, CISC 472: Medical Informatics
Winter 2017, Queen's University, Kingston, Canada
Topic: Medical Education Informatics

Fall 2014 COMP 329: Introduction to Computer-Integrated Surgery
Queen's University, Kingston, Canada
Computer-Assisted Interventions Training

Teaching Assistantship

- Winter 2018 CISC 352: Artificial Intelligence
Queen's University, Kingston, Canada
- Fall 2017 CISC 102: Discrete Mathematics for Computer Science I
Queen's University, Kingston, Canada
- Winter 2015 CISC 271: Scientific Computing
Queen's University, Kingston, Canada
- Fall 2013 CISC 101: Elements of Computing Science
Queen's University, Kingston, Canada
- Fall 2012 CISC 121: Introduction to Computing Science
Queen's University, Kingston, Canada

Supervision/Mentoring Experience

(student awards indicated inline)

Master's Students Supervised in Thesis/Project

- 2023 - Elham Hekmatnia
Program: Master of Computer Science - Data Science, Analytics, and Artificial Intelligence (Carleton University)
Project: Orthodontic X-ray Analysis for Monitoring Malocclusion
- 2023 - 2024 Booshra Nazifa Mahmud
Program: Master of Computer Science (Carleton University)
Project: Domain Knowledge and Data Augmentation for Improved Time Series Classification
- 2020 - 2024 Anthony Tasca (co-supervised with Ahmed El-Roby)
Program: Master of Computer Science (Carleton University)
Project: Human Deepfake Detection
- 2019 - 2024 Mehardeep Bhalla Singh
Program: Master of Computer Science - Data Science Specialization (Carleton University)
Project: Multi-Sensor Assessment of Skill in Point-of-care Ultrasound
- 2021 - 2023 Daniil Kulik
Program: Master of Computer Science (Carleton University)
Project: Synthetic Ultrasound Video Generation
- 2021 - 2022 Janine Hsu
Program: Master of Applied Science - Biomedical Engineering (Carleton University)
Project: Vasospasm Detection in Brain Images
Award: 2022 Michael T. Richard Clinical Research Fellowship in Neurosurgery at the Ottawa Brain and Mind Research Institute

- 2020 - 2022 Ummey Hani Tanin
Program: Master of Computer Science - Data Science Specialization (Carleton University)
Project: Deep Video Analysis Methods for Surgical Skills Assessment in Cataract Surgery
- 2020 - 2021 Kun Yuan (co-supervised with WonSook Lee)
Program: Master of Computer Science - Artificial Intelligence (University of Ottawa)
Project: Surgical Workflow Anticipation
Award: 2022 Joseph De Koninck Thesis Prize at University of Ottawa
Award: 2021 MICCAI Young Scientist Award

Undergraduate Students Supervised in Honours Thesis/Project

- 2025 - Raymond Chan
Program: Bachelor of Computer Science (Carleton University)
Project: Evaluating Hand Motion as a Tool for Surgical Workflow Analysis
- 2024 - Jason Au
Program: Bachelor of Computer Science (Carleton University)
Project: Measuring the Effect of Registration and Calibration Errors in Deep Learning for Surgical Skills Assessment
- 2024 - Zeynep Kocacenk
Program: Bachelor of Computer Science (Carleton University)
Project: User Interfaces for Deep Learning on Image-Guide Interventions Data
- 2024 - Tony Tu
Program: Bachelor of Computer Science (Carleton University)
Project: Predicting Landing Points in Helicopter Flight Paths
- 2024 Gurpiar Brar
Program: Bachelor of Computer Science (Carleton University)
Project: Predicting Learning Curves in Diagnostic Ultrasound
- 2023 - 2024 Uvernes Somarriba Castillo
Program: Bachelor of Computer Science (Carleton University)
Project: Reinforcement Learning in Simulated Surgery
- 2023 - 2024 Ujan Sen
Program: Bachelor of Computer Science (Carleton University)
Project: Using a Large Language Model (LLM) for Coaching on a Medical Intervention Task
- 2023 - 2024 Bining Long
Program: Bachelor of Computer Science (Carleton University)
Project: Integrating Domain Knowledge in Deep Learning for Pediatric Appendicitis Diagnosis
- 2023 Jake Taylor
Program: Bachelor of Computer Science (Carleton University)
Project: Ultrasound Image Processing via Generative Adversarial Networks

- 2022 - 2023 Sreepriya Pulyassary
Program: Bachelor of Computer Science (Carleton University)
Project: Vasospasm Detection Using Deep Learning and Domain Knowledge
- 2022 Chris Milan
Program: Bachelor of Computer Science (Carleton University)
Project: Deep Learning Algorithm to Automate Cerebral Vasospasm Detection
- 2022 Kheri Hughes
Program: Bachelor of Computer Science (Carleton University)
Project: Classifying scans in FAST ultrasound videos using convolutional neural networks
- 2021 - 2022 Ilan Gofman
Program: Bachelor of Computer Science (Carleton University)
Project: Classifying points of interest in FAST ultrasound videos using deep neural networks
- 2021 Mahad Elmi
Program: Bachelor of Computer Science (Carleton University)
Project: Using Self-Attention on Ultrasound-Guided Needle Insertion Skill Assessment Data
- 2021 Japinder Sandhu
Program: Bachelor of Computer Science (Carleton University)
Project: Time Series AI Video Editing
- 2021 Jeong Won Kim
Program: Bachelor of Computer Science (Carleton University)
Project: Colorization of Black and White Images Using Machine Learning
- 2020 Vineel Boddula
Program: Bachelor of Computer Science (Carleton University)
Project: Supervised Video Summarization for Ultrasound
- 2020 - 2021 Daniil Kulik
Program: Bachelor of Computer Science (Carleton University)
Project: Motion Analysis in Diagnostic Ultrasound
- 2020 Robert Tyrrell
Program: Bachelor of Computer Science (Carleton University)
Project: Skills and Context Recognition from Ultrasound Image Sequences
- 2019 Dehao Liu
Program: Bachelor of Computer Science (Carleton University)
Project: Point-of-care Ultrasound Skills Level Assessment by Machine Learning

Undergraduate Students Supervised in Research

- 2025 - Raymond Chan
Program: Bachelor of Computer Science (Carleton University)
Project: Surgical Tool Tracking in 6-DOF with RGBD Cameras
Award: Carleton University I-CUREUS Program

- 2023 Connor Baillie
Program: Bachelor of Computer Science (Carleton University)
Project: Ultrasound-Guided Intervention Classification from Video
Award: Carleton University Dean's Summer Research Internship
- 2023 Ayoub Dahir
Program: Bachelor of Computer Science (Carleton University)
Project: Surgical Skills Classification from Extracted Features
Award: Carleton University Dean's Summer Research Internship
- 2023 Sreepriya Pulyassary
Program: Bachelor of Computer Science (Carleton University)
Project: Vasospasm Detection Using Deep Learning and Domain Knowledge
Award: Carleton University I-CUREUS Program
- 2021 Raymond Chan
Program: Bachelor of Computer Science (Carleton University)
Project: Simulating 2D Surgical Videos from 3D Pose Tracking Data for Skills Assessment
Award: NSERC Undergraduate Student Research Award
- 2021 Uvernes Somarriba Castillo
Program: Bachelor of Computer Science (Carleton University)
Project: Data Augmentation Strategies for Time Series in Interventional Healthcare
Award: Carleton University Dean's Summer Research Internship
- 2021 Damien Hood
Program: Bachelor of Computer Science (Carleton University)
Project: Characterizing Hand Motion for Data Augmentation in Interventional Healthcare
Award: Carleton University Dean's Summer Research Internship
- 2021 Daniil Kulik
Program: Bachelor of Computer Science (Carleton University)
Project: Motion Analysis in Diagnostic Ultrasound
Award: Carleton University I-CUREUS Program
- 2020 - 2021 Ujan Sen
Program: Bachelor of Computer Science (Carleton University)
Project: Monitoring Learning Curves in Simulated Colonoscopy
Award: Carleton University Dean's Summer Research Internship

Students Mentored in Research

- 2022 - 2023 Lucas Gomez
Program: Bachelor of Computer Science (Carleton University)
Project: Deep Convolutional Spiking Neural Networks and the Human Visual System
- 2017 - 2018 Sachin Pasricha
Program: Doctor of Medicine (Queen's University)
Project: Monitoring Learning Curves in Ultrasound-Guided Needle Insertion Training

- 2016 - 2017 Sean Xia
Program: Doctor of Medicine (Queen's University)
Project: Computer-Assisted Training for Ultrasound-Guided Needle Insertions
- 2016 - 2017 Hillary Lia
Program: Bachelor of Computer Science (Queen's University)
Project: Skills Assessment in Ultrasound-Guided Needle Insertions
- 2015 - 2017 Vinyas Harish
Program: Bachelor of Computer Science (Queen's University)
Project: Image-Guided Interventions Training
- 2015 - 2016 Kyle MacNeil
Program: Bachelor of Computer Science (Queen's University)
Project: Objective Evaluation of Colonoscopy Procedural Skills Using Motion Analysis

Awards/Honours

- 2019 NSERC Postdoctoral Fellowship (ended early)
Natural Sciences and Engineering Research Council of Canada
- 2017 - 2018 Modelling, Simulation, and Training Fellowship
Link Foundation, Binghamton, USA
- 2017 PhD Research Achievement Award in Computing
Queen's University, Kingston, Canada
- 2016 - 2017 Walter C. Sumner Memorial Fellowship Award
Walter C. Sumner Foundation, Halifax, Canada
- 2016 Rennes Métropole Soutien à la Mobilité des Doctorants
Rennes Métropole, Rennes, France
- 2015 - 2016 Mitacs Globalink Research Award - Campus France
Mitacs Canada
- 2015 Distinguished Master's Thesis in Computing
Queen's University, Kingston, Canada
- 2015 ISCAS Student Travel Scholarship
International Society for Computer Aided Surgery
- 2014 - 2017 NSERC Canada Graduate Scholarship - Doctoral
Natural Sciences and Engineering Research Council of Canada
- 2013 - 2014 Ontario Graduate Scholarship
Ontario Ministry of Training, Colleges and Universities
- 2012 - 2013 NSERC Canada Graduate Scholarship - Master's
Natural Sciences and Engineering Research Council of Canada

- 2012 - 2013 Ontario Graduate Scholarship (declined)
Ontario Ministry of Training, Colleges and Universities
- 2012 Dillon Gold Medal in Applied Mathematics
Western University, London, Canada
- 2012 Gold Medal in Honors Double Major Physics
Western University, London, Canada
- 2012 Borwein Memorial Prize
Western University, London, Canada
- 2011 SPIE Student Travel Grant
Society for Photographic Instrumentation Engineers, Bellingham, USA
- 2011 NSERC CREATE Training Program in Bone and Joint Health Technologies
Natural Sciences and Engineering Research Council of Canada
- 2011 Albert O. Jeffery Scholarship in Applied Mathematics
Western University, London, Canada
- 2010 - 2011 Robert and Ruth Lumsden Scholarship in Science
Western University, London, Canada
- 2010 NSERC Undergraduate Student Research Award
Natural Sciences and Engineering Research Council of Canada
- 2010 Steinmetz-Woonton Scholarship
Western University, London, Canada
- 2010 University of Western Ontario Faculty Association Scholarship
Western University, London, Canada
- 2009 - 2012 Sarah and Andrew Hamilton Scholarship
Western University, London, Canada
- 2008 - 2012 Continuing Admission Scholarship
Western University, London, Canada

Professional Activities

Conference Organization

- 2024, 2023 Data Day 9.0
Carleton University, Ottawa, Canada
Planning Committee and Poster Judge
- 2023 International Conference on Information Processing in Computer-Assisted Interventions
Awards Panel

2011 - 2012 Scholar's Electives Program Conference
Western University, London, Canada
Fundraising and Advertising Committee

Journal Article Reviews (ad hoc)

2024 - Nature Communications Medicine
2023 - IEEE Journal of Biomedical and Health Informatics
2023 - SPIE Journal of Medical Imaging
2018 - International Journal of Computer Assisted Radiology and Surgery
2017 - Journal of Medical Robotics Research
2017 - IEEE Transactions on Medical Imaging
2017 - IEEE Transactions on Biomedical Engineering

Conference Paper/Abstract Reviews (recurring)

2020 - Information Processing in Computer-Assisted Interventions
2019 - Imaging Network Ontario
2017 - SPIE Medical Imaging
2015 - Medical Image Computing and Computer Assisted Interventions (including workshops)

Grant Proposal Peer Reviews (ad hoc)

2020 - Mitacs Accelerate

Selected Outreach Activities

2020 cuHacking Hackathon
Carleton University, Ottawa, Canada
General Judge
2014 - 2018; Perk Lab Slicer Bootcamp
2022 Queen's University, Kingston, Canada
PLUS, SlicerIGT, and Perk Tutor platforms for image-guided interventions research

- 2015 SEAMO Innovation Showcase
Queen's University, Kingston, Canada
Perk Tutor platform for image-guided interventions training
- 2013 - 2014 Science Rendezvous Kingston
Queen's University, Kingston, Canada
SlicerIGT, Perk Tutor, and Mobile Image Overlay Software
- 2013 - 2014 Queen's University Discovery Day
Canadian Medical Hall of Fame
SlicerIGT, Perk Tutor, and Mobile Image Overlay Software

Invited Talks

- 2023 IEEE EMBS/OCIBME Seminar Series
Improving outcomes in surgery with machine learning
- 2021 Carleton University Data Day 7.1
Panel Discussion on Future of AI
- 2019 Ontario Health IT Conference
Panel Discussion on AI and Precision Medicine: Using AI, big data analytics and genomics to predict, prevent and cure diseases, and make individualized treatment decisions

Publications

Journal Articles

- [1] G. Salame, **M. S. Holden**, B. P. Lucas, and A. Portillo, "Change in economy of ultrasound probe motion among general medicine trainees," *The Ultrasound Journal*, vol. 16, no. 5, 2024. DOI: 10.1186/s13089-023-00345-2.
- [2] S. B. Shafei, S. Shadpour, J. L. Mohler, E. C. Kauffman, **M. S. Holden**, and C. Gutierrez, "Classification of subtask types and skill levels in robot-assisted surgery using eeg, eye-tracking, and machine learning," *Surgical Endoscopy*, vol. 38, no. 9, pp. 5137–5147, 2024. DOI: 10.1007/s00464-024-11049-6.
- [3] D. Kulik, C. R. Bell, and **M. S. Holden**, "Fast skill assessment from kinematics data using convolutional neural networks," *International Journal of Computer Assisted Radiology and Surgery*, pp. 1–7, 2023. DOI: 10.1007/s11548-023-02908-z.
- [4] J. Ruzicki, **M. S. Holden**, S. Cheon, T. Ungi, R. Egan, and C. Law, "Use of machine learning to assess cataract surgery skill level with tool detection," *Ophthalmology Science*, vol. 3, no. 1, p. 100235, 2023. DOI: 10.1016/j.xops.2022.100235.
- [5] R. Prager, P. Pageau, T. Hodges, C. Yan, M. Woo, M.-J. Nemnom, S. Millington, **M. S. Holden**, R. St-Gelais, and W. J. Cheung, "Characterizing the biomechanical differences between novice and expert point-of-care ultrasound practitioners using a low-cost gyroscope and accelerometer integrated sensor: A pilot study," *AEM Education and Training*, vol. 6, no. 2, e10733, 2022. DOI: 10.1002/aet2.10733.
- [6] A. N. Tasca, S. Carlucci, J. C. Wiley, **M. S. Holden**, A. El-Roby, and G. A. Tasca, "Detecting defense mechanisms from adult attachment interview (aai) transcripts using machine learning," *Psychotherapy Research*, pp. 1–11, 2022. DOI: 10.1080/10503307.2022.2156306.

- [7] K. Yuan, **M. S. Holden**, S. Gao, and W. Lee, “Anticipation for surgical workflow through instrument interaction and recognized signals,” *Medical Image Analysis*, vol. 82, p. 102611, 2022. DOI: 10.1016/j.media.2022.102611.
- [8] **M. S. Holden**, M. O’Brien, A. Malpani, H. Naz, Y.-W. Tseng, L. Ishii, S. S. Vedula, M. Ishii, and G. Hager, “Reconstructing the nasal septum from instrument motion during septoplasty surgery,” *Journal of Medical Imaging*, vol. 8, no. 6, p. 065001, 2021. DOI: 10.1117/1.JMI.8.6.065001.
- [9] **M. S. Holden**, A. Portillo, and G. Salame, “Skills classification in cardiac ultrasound with temporal convolution and domain knowledge using a low-cost probe tracker,” *Ultrasound in Medicine & Biology*, vol. 47, no. 10, pp. 3002–3013, 2021. DOI: 10.1016/j.ultrasmedbio.2021.06.011.
- [10] C. R. Bell and **M. S. Holden**, “Wanted: Automated objective proficiency assessment metrics for the fast exam (and other pocus studies),” *European Journal of Trauma and Emergency Surgery*, pp. 1–2, 2019, Letter to the Editor. DOI: 10.1007/s00068-019-01156-8.
- [11] **M. S. Holden**, S. Xia, H. Lia, Z. Keri, C. Bell, L. Patterson, T. Ungi, and G. Fichtinger, “Machine learning methods for automated technical skills assessment with instructional feedback in ultrasound-guided interventions,” *International Journal of Computer Assisted Radiology and Surgery*, pp. 1–11, 2019. DOI: 10.1007/s11548-019-01977-3.
- [12] R. McGraw, Z. Keri, T. Chaplin, L. Rang, M. Jaeger, N. Rocca, **M. S. Holden**, Z. Keri, and G. Fichtinger, “Cognitive load theory as a framework for simulation-based, ultrasound-guided internal jugular catheterization training: Once is not enough,” *Canadian Journal of Emergency Medicine*, vol. 21, no. 1, pp. 141–148, 2019. DOI: 10.1017/cem.2018.456.
- [13] C. Yeo, J. Ring, **M. S. Holden**, T. Ungi, A. Toprak, G. Fichtinger, and B. Zevin, “Surgery tutor for computational assessment of technical proficiency in soft-tissue tumor resection in a simulated setting,” *Journal of surgical education*, vol. 76, no. 3, pp. 872–880, 2019. DOI: 10.1016/j.jsurg.2018.11.005.
- [14] **M. S. Holden**, C. N. Wang, K. MacNeil, B. Church, L. Hookey, G. Fichtinger, and T. Ungi, “Objective assessment of colonoscope manipulation skills in colonoscopy training,” *International Journal of Computer Assisted Radiology and Surgery*, vol. 13, no. 1, pp. 105–114, 2018. DOI: 10.1007/s11548-017-1676-4.
- [15] **M. S. Holden**, Y. Zhao, C. Haegelen, C. Essert, S. Fernandez-Vidal, E. Bardinet, T. Ungi, G. Fichtinger, and P. Jannin, “Self-guided training for deep brain stimulation planning using objective assessment,” *International Journal of Computer Assisted Radiology and Surgery*, vol. 13, no. 7, pp. 1129–1139, 2018. DOI: 10.1007/s11548-018-1753-3.
- [16] C. R. Bell, C. McKaigney, **M. S. Holden**, G. Fichtinger, and L. Rang, “Sonographic accuracy as a novel tool for point-of-care ultrasound competency assessment,” *AEM Education and Training*, vol. 1, no. 4, pp. 316–324, 2017. DOI: 10.1002/aet2.10064.
- [17] R. McGraw, T. Chaplin, C. McKaigney, L. Rang, M. Jaeger, D. Redfearn, C. Davison, T. Ungi, **M. S. Holden**, C. Yeo, Z. Keri, and G. Fichtinger, “Development and evaluation of a simulation-based curriculum for ultrasound-guided central venous catheterization,” *Canadian Journal of Emergency Medicine*, vol. 18, no. 6, pp. 405–413, 2016. DOI: 10.1017/cem.2016.329.
- [18] D. Clinkard, **M. S. Holden**, T. Ungi, C. Davison, D. Messenger, G. Fichtinger, and R. McGraw, “The development and validation of hand motion analysis to evaluate competency in central line catheterization,” *Academic Emergency Medicine*, vol. 22, no. 2, pp. 212–218, 2015. DOI: 10.1111/acem.12590.
- [19] D. Clinkard, E. Moulton, **M. S. Holden**, C. Davison, T. Ungi, G. Fichtinger, and R. C. McGraw, “Assessment of lumbar puncture skill in experts and nonexperts using checklists and quantitative tracking of needle trajectories: Implications for competency-based medical education,” *Teaching and learning in medicine*, vol. 27, no. 1, pp. 51–56, 2015. DOI: 10.1080/10401334.2014.979184.
- [20] Z. Keri, D. Sydor, T. Ungi, **M. S. Holden**, P. Mousavi, R. McGraw, D. Borschneck, G. Fichtinger, and M. Jaeger, “Computerized training system for ultrasound-guided lumbar puncture on abnormal spine models: A randomized controlled trial,” *Canadian Journal of Anesthesia/Journal canadien d’anesthésie*, vol. 62, no. 7, pp. 777–784, 2015. DOI: 10.1007/s12630-015-0367-2.

- [21] C. Yeo, C. Davison, T. Ungi, **M. S. Holden**, G. Fichtinger, and R. McGraw, “Examination of learning trajectories for simulated lumbar puncture training using hand motion analysis,” *Academic Emergency Medicine*, vol. 22, no. 10, pp. 1187–1195, 2015. DOI: 10.1111/acem.12753.
- [22] **M. S. Holden**, T. Ungi, D. Sargent, R. C. McGraw, E. C. S. Chen, S. Ganapathy, T. M. Peters, and G. Fichtinger, “Feasibility of real-time workflow segmentation for tracked needle interventions,” *IEEE Transactions on Biomedical Engineering*, vol. 61, no. 6, pp. 1720–1728, 2014. DOI: 10.1109/tbme.2014.2301635.
- [23] T. Ungi, D. Beiko, M. Fuoco, F. King, **M. S. Holden**, G. Fichtinger, and R. Siemens, “Tracked ultrasonography snapshots enhance needle guidance for percutaneous renal access: A pilot study,” *Journal of Endourology*, vol. 28, no. 9, pp. 1040–1045, 2014. DOI: 10.1089/end.2014.0011.
- [24] **M. S. Holden**, D. G. C. McKeon, and T. N. Sherry, “The double slit experiment with polarizers,” *Canadian Journal of Physics*, vol. 89, no. 11, pp. 1079–1081, 2011. DOI: 10.1139/p11-122.

Conference Proceedings

- [1] U. Tanin, A. Duimering, C. Law, J. Ruzicki, G. Luna, and **M. S. Holden**, “Performance evaluation in cataract surgery with an ensemble of 2d-3d convolutional neural networks,” in *Healthcare Technology Letters*, 2024. DOI: 10.1049/htl2.12078.
- [2] J. Yang, R. Hisey, J. Bierbrier, C. Law, G. Fichtinger, and M. Holden, “Frame selection methods to streamline surgical video annotation for tool detection tasks,” in *2024 IEEE Canadian Conference on Electrical and Computer Engineering (CCECE)*, IEEE, 2024, pp. 892–898. DOI: 10.1109/CCECE59415.2024.10667104.
- [3] K. Barr, L. Hookey, T. Ungi, G. Fichtinger, and **M. S. Holden**, “Analyzing colonoscopy training learning curves using comparative hand tracking assessment,” in *Medical Imaging 2023: Image-Guided Procedures, Robotic Interventions, and Modeling*, SPIE, vol. 12466, 2023, pp. 466–472. DOI: 10.1117/12.2654309.
- [4] B. Long, Y. Guan, and **M. S. Holden**, “A two-stage neural network model for breast ultrasound image classification,” in *IEEE 23rd International Conference on Bioinformatics and Bioengineering (BIBE)*, IEEE Computer Society, 2023, pp. 129–133. DOI: 10.1109/BIBE60311.2023.00028.
- [5] R. W. Chan, R. Hisey, and **M. S. Holden**, “Feasibility of video-based skills assessment: A study on ultrasound-guided needle insertions using simulated projections,” in *Medical Imaging 2022: Image-Guided Procedures, Robotic Interventions, and Modeling*, SPIE, vol. 12034, 2022, pp. 663–669. DOI: 10.1117/12.2613199.
- [6] O. O’Driscoll, R. Hisey, **M. S. Holden**, D. Camire, J. Erb, D. Howes, T. Ungi, and G. Fichtinger, “Feasibility of object detection for skill assessment in central venous catheterization,” in *Medical Imaging 2022: Image-Guided Procedures, Robotic Interventions, and Modeling*, SPIE, vol. 12034, 2022, pp. 358–365. DOI: 10.1117/12.2607294.
- [7] K. Yuan, **M. S. Holden**, S. Gao, and W.-S. Lee, “Surgical workflow anticipation using instrument interaction,” in *International Conference on Medical Image Computing and Computer-Assisted Intervention*, Springer, 2021, pp. 615–625. DOI: 10.1007/978-3-030-87202-1_59.
- [8] R. Liu and **M. S. Holden**, “Kinematics data representations for skills assessment in ultrasound-guided needle insertion,” in *Medical Ultrasound, and Preterm, Perinatal and Paediatric Image Analysis*, Springer, 2020, pp. 189–198. DOI: 10.1007/978-3-030-60334-2_19.
- [9] R. E. Tyrrell and **M. S. Holden**, “Ultrasound video analysis for skill level assessment in fast ultrasound,” in *Computer Methods in Biomechanics and Biomedical Engineering: Imaging & Visualization*, vol. 0, Taylor & Francis, 2020, pp. 1–5. DOI: 10.1080/21681163.2020.1835549.
- [10] J. Laframboise, T. Ungi, L. Hookey, A. Lasso, M. Asselin, **M. S. Holden**, and G. Fichtinger, “Analyzing the curvature of the colon in different patient positions,” in *Medical Imaging 2019: Image-Guided Procedures, Robotic Interventions, and Modeling*, International Society for Optics and Photonics, vol. 10951, 2019, 109512F. DOI: 10.1117/12.2512455.

- [11] D. Garcia-Mato, **M. S. Holden**, A. Lasso, A. Szulewski, J. Pascau, and G. Fichtinger, “3d gaze tracking for skill assessment in ultrasound-guided needle insertions,” in *32nd International Congress and Exhibition of Computer Assisted Radiology and Surgery*, vol. Supplement 1, 2018, S52–S53. DOI: 10.1007/s11548-018-1766-y.
- [12] R. Hisey, T. Ungi, **M. S. Holden**, Z. Baum, Z. Keri, C. McCallum, D. W. Howes, and G. Fichtinger, “Real-time workflow detection using webcam video for providing real-time feedback in central venous catheterization training,” in *Medical Imaging 2018: Image-Guided Procedures, Robotic Interventions, and Modeling*, Honorable mention poster award, International Society for Optics and Photonics, vol. 10576, 2018, p. 1057620. DOI: 10.1117/12.2293494.
- [13] R. Leung, A. Lasso, **M. S. Holden**, B. Zevin, and G. Fichtinger, “Exploration using holographic hands as a modality for skills training in medicine,” in *Medical Imaging 2018: Image-Guided Procedures, Robotic Interventions, and Modeling*, International Society for Optics and Photonics, vol. 10576, 2018, p. 1057611. DOI: 10.1117/12.2295495.
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- [5] J. Hsu, I. Churchill, **M. S. Holden**, and H. Lesiuk, “Prediction of cerebral vasospasm using radiographical and clinical features: A machine learning model,” Canadian Neurological Sciences Federation Congress, 2023.
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- [11] S. Pasricha, Z. Keri, **M. S. Holden**, and G. Fichtinger, “Developing a simulation curriculum to teach medical students to perform an ultrasound-guided needle insertion,” Canadian Conference on Medical Education, 2019.
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Theses

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- [2] **M. S. Holden**, “Linear object registration for image-guided interventions,” M.S. thesis, Queen’s University, 2014.

Patents/Inventions

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Funding

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- [3] **M. S. Holden**, *Start-up grant*, Carleton University, 2019.
- [4] B. Zevin, C. T. Yeo, J. Ring, **M. S. Holden**, T. Ungi, and G. Fichtinger, *Proficiency-based training in soft tissue resection using real-time computer navigation feedback from the surgery tutor*, Southeastern Ontario Academic Medical Organization (SEAMO) Endowed Scholarship and Education Fund, 2018.