Dominik Mattioli, Ph.D. Curriculum Vitae

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Education

Ph.D. Industrial Engineering, *University of Iowa (UIowa)*, Iowa City, IA *2018 – 2021*
- ◇ Committee: Geb Thomas (Chair), Don Anderson, Matt Karam, Priya Pennathur, Steve Baek.
- ◇ Graduate Certificate in Informatics Information Science.

M.S. Civil Engineering, *Ohio State University (OSU)*, Columbus, OH *2015 – 2017*
- ◇ Committee: Ethan Kubatko (Chair), Alan Zundel, Gil Bohrer, Abdollah Shafieezadeh.

B.S. Civil Engineering, *OSU*, Columbus, OH *2011 – 2015*
- ◇ Minor in Economics

Current Position

Research (MLOps) Engineer, *UIowa*, Iowa City, IA *2023 – Present*

Lead scientist researching and developing machine learning operation tools and protocols for an orthopedic data science team.

- ◇ Developed a wrapper library for intuitive client-side interaction with an XNAT server; designed to facilitate uploading/downloading/querying of 200+ OR radiograph sequences (and derived data) from 3 university hospitals.
- ◇ Minimized required crowdsource labor costs for procuring semantic segmentation data ($0.07/image) to achieve 96% accuracy.
- ◇ Refined a multi-label U-Net-based system for measuring geometric relationships between key features in radiographs.
- ◇ Assembled automatic skill assessment systems into a web applet for institutions to receive scores for their uploaded OR data.
- ◇ Mentored novice researchers on the full-cycle development of computer vision-based systems for technical skills assessment.

Prior Positions

Postdoctoral Researcher, *University of Virginia (UVA)*, Charlottesville, VA *2022 – 2023*

Modeled 3D digital human performance analysis for injury prevention of professional football players using multi-stereo 2D videos.

- ◇ Implemented synthetic data generation pipeline, creating a 30,000 2D image dataset of random and biofidelic 3D SMPL human models.
- ◇ Developed and trained a convolutional autoencoder to render 3D human models given 2D pose, shape, and camera parameters.
- ◇ Applied SciPy optimization framework to register pose, shape, and camera parameters from a given input image.
- ◇ Adapted an advanced 3D neural rendering framework (ML-Neuman) to incorporate multiple synchronized camera view inputs.
- ◇ Conducted literature and source code sandboxing with state-of-the-art 3D neural rendering techniques, e.g., NeRF, COLMAP, ML-Neuman.

Graduate Research Assistant, *UIowa*, Iowa City, IA *2018 – 2021*

Developed a novel framework for more objective, data-driven, and cost-effective orthopedic technical skills assessment.

- ◇ Conducted an evidence-based systematic literature review under the PRISMA framework on orthopedic technical skills assessment and surgical simulators.
- ◇ Implemented a relational database for sensitive medical images and their corresponding analysis and

DICOM metadata.
- ◇ Expanded available training data 3x via crowdsourcing and generative image synthesis algorithms.
- ◇ Trained a multi-object semantic segmentation network to identify pertinent objects in radiographs with 95% accuracy.
- ◇ Prototyped a user interface (UI) that reduced the cost of assessing technical skills from radiographs by 2.5x.
- ◇ Published a usability study showing that my interface elevated novice users to comparable performance as expert annotators.
- ◇ Employed forward model-building design and multi-variate equations for predicting expert evaluations with 70% accuracy.
- ◇ Demonstrated through a paired comparison study that consensus expert opinion can be explained by specific objective metrics.
- ◇ Coordinated and participated in weekly and bimonthly meetings with medical (augmented reality) device teams and surgeons.
- ◇ Led the publication process (liaising, drafting, revision) of three manuscripts on algorithmic orthopedic technical skill assessment.

Research Engineer, *UIowa*, Iowa City, IA *2018*

Derived image-based evidence linking carpal tunnel syndrome (CTS) to characteristic movement of the median nerve.

- ◇ Prototyped an interface for automatic marker-based tracking in ultrasound videos given a single-click input and published evidence on a correlative relationship between CTS and constrained movement of the median nerve.

Graduate Research Assistant, *OSU*, Columbus, OH *2015 – 2017*

Combined informed heuristics with graph theory to bring automatic quadrangular and mixed-element (2D) mesh generation to hydrodynamic domains.

- ◇ Published thesis detailing a novel heuristic based algorithm for indirectly converting an initial triangulation into a quadrangular or mixed-element domain without significantly reducing average element quality or scaling.
- ◇ Programmed an extensible data structure and UI for visualizing my algorithm's progression and concluding assessment of its quality.
- ◇ Accepted for three competitive awards to present my research at three international computational mechanics conferences.
- ◇ As of July 2024, currently converting methodology to use Reinforcement-Learning instead of heuristic rule-based triangle-to-quad conversion methodology.

Manuscripts

- ◇ **Mattioli DD**, Thomas GW, Connor EE, Long SA, Kowalski HR, Anderson DD. (Jun 2024, accepted pending minor revisions) *An aggregation of individual expert opinions agrees with objective analysis for a core orthopedic technical skill.* IISE Trans on HC Sys Engr, DOI: 10.13140/RG.2.2.12042.85446/1.
- ◇ **Mattioli DD**, Thomas GW, Long SA, Röfling JD, Anderson DD. (2023) *Fluoroscopic image-based behavior analysis can objectively explain subjective expert assessment of wire navigation skill*, J Orthop Res, 1-1, DOI: 10.1002/jor.25685.
- ◇ **Mattioli DD**, Thomas GW, Long SA, Tatum M, Anderson DD. (2022) *Minimally trained analysts can perform fast, objective assessment of orthopedic technical skill from fluoroscopic images*, IISE Trans on HC Sys Engr, 12:3, 212-220, DOI: 10.1080/24725579.2022.2035022.
- ◇ **Mattioli DD**. *Orthopedic data science: fluoroscopic image analysis for the objective assessment of technical skill.* (2021) The Univ of Iowa ProQuest Dissertations Pub, 1:102, 28866581.
- ◇ Thomas GW, Long SA, Tatum M, Kowalewski T, **Mattioli DD**, Marsh JL, Kowalski HR, Karam MD, Bechtold J, Anderson DD. *A vision for using simulation & virtual coaching to improve the community practice of orthopedic trauma surgery.* The Iowa Orthop J, 40(1): 25-34.

- **Mattioli DD**. *QuADMESH+: A quadrangular advanced mesh generator for hydrodynamic models.* (2017) The Ohio State Univ, OhioLink Thesis Pub, 1:110.

Conference Papers, Presentations, & Posters

- Baek SS, **Mattioli DD**, Annapareddy N, Wang J, Niu J, Havaldar A. *Mathematical space of human body shapes.* University of Virginia DataPalooza 2022, Charlottesville, VA, Nov 2022.
- Kowalski HR, **Mattioli DD**, Thomas GW, Connor EE, Long SA, Anderson DD. *Objective fluoroscopic assessment of pediatric supracondylar humerus fracture fixation quality agrees with subjective expert opinion.* American Academy of Orthopaedic Surgeons (AAOS 2022), Chicago, IL, 22-26 Mar. 2022.
- **Mattioli DD**, Kubatko EJ, Wood D. *A quadrilateral mesh generation technique with application to shallow water modeling.* 16th U.S. National Congress on Computational Mechanics (USNCCM16), Chicago, IL (remote), 25-29 Jul. 2021.
- **Mattioli DD**, Thomas, GW, Long SA, Tatum M, Karam MD, Anderson DD. *Discriminating wire navigation performance using quantitative objective analysis of intra-operative fluoroscopy.* 12th International Conference on Applied Human Factors and Ergonomics (AHFE 2021), Manhattan, NY (remote), 25-29 Jul. 2021.
- **Mattioli DD**, Thomas GW, Connor EE, Long SA, Kowalski HR, Tatum M, Tinker B, Anderson DD. *Semi-automated objective scoring of orthopedic trauma fixation performance from fluoroscopy.* Healthcare Systems Process Improvement Conference (HSPI 2021), Orlando, FL (remote), 24-26 Feb. 2021.
- **Mattioli DD**, Thomas GW. *A semi-automated system for wire navigation skills assessment.* Fall 2020 Annual Institute of Industrial & Systems Engineers (IISE) Doctoral Student Colloquium, New Orleans, LA (remote), 31 Oct. 2020.
- Long SA, **Mattioli DD**, Connor EE, Thomas GW, Anderson DD, Kowalski HR *Establishing performance metrics on pinning pediatric elbow fractures: from simulation to the operating room.* 2020 American College of Surgeons Surgeons and Engineers: A Dialogue on Surgical Simulation, Chicago, Illinois, 20 Mar. 2020.
- **Mattioli DD**, Buckwalter JA, Lawler EA, Goetz JE. (Aug. 2018). *Dynamic ultrasound analysis of median nerve may differentiate clinically significant carpal tunnel syndrome.* 42nd Annual Meeting of the American Society of Biomechanics (ASB), Rochester, Minnesota, 8-11 Aug. 2018.
- **Mattioli DD**, Kubatko EJ, Zundel A. *Applying a triangular, quadrangular, and mixed-element mesh generation technique to shallow water flow Domains.* 14th U.S. National Congress on Computational Mechanics (USNCCM14), Montreal, Canada, 17-20 July 2017.
- **Mattioli DD**, Kubatko EJ, Zundel A. *qADMESH+: an automatic quadrangular and mixed-element advanced mesh generator.* 19th International Conference on Finite Elements in Flow Problems (FEF 2017), Rome, Italy, 5-7 Apr. 2017.
- **Mattioli DD**, Kubatko EJ, Zundel A. *Automatic Mesh generation techniques for adapting triangular meshes to quadrilateral and mixed-element meshes.* 12th World Congress on Computational Mechanics (WCCM XII), Seoul, Korea, 24-26 Jul. 2016.

Awards & Honors

- William H. Harris, MD Award Nominee – Orthopedic Research Society *2023*
- Research Grant Award – UIowa Graduate & Student Professional Government (GPSG) *2021*
- Congress Award – USNCCM16 *2021*
- Travel Grant Award – UIowa GPSG *2020*
- IISE 18th Annual Doctoral Colloquium Nominee – UIowa *2019*
- Travel Grant Award – USNCCM14 *2017*
- Travel Grant Award – OSU Office of Energy and Environment *2017*
- Travel Grant Award – U.S. Assoc. for Comp. Mechanics *2016*
- Bedford Travel Award – OSU College of Engineering *2016*
- National Buckeye Scholarship – OSU *2011 – 2015*
- Stadium Scholarship Program Scholarship – OSU *2011 – 2012*

Professional Activities

Reviewer of Scientific Journals

- IISE: Transactions on Healthcare Systems Engineering, Taylor & Francis — *2022 – Pres.*
- Journal of Computational Design and Engineering, Elsevier — *2022 – 2023*

Reviewer – Other

- UIowa GPSG — *2019 – 2021*

Service Activities

- Data Team Volunteer – Commuters Take Action, Chicago, IL — *2023 – Pres*
- Treasurer – UIowa Human Factors Engineering Society — *2019 – 2021*
- Senior Graduate Mentor – UIowa — *2019 – 2021*
- MESA Tutor – UIowa — *2020 – 2020*
- EMPOWER Ambassador – UIowa — *2020 – 2020*
- Community/Resident Advisor – OSU — *2015*
- Aquatic Facility Coordinator – OSU — *2011 – 2015*
- India Engineering and Service Expedition – OSU — *2014*
- Stadium Scholarship Program – OSU — *2011 – 2013*