Samuel Ehrenstein

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Interests

AI + Health, Medical Imaging, 3D Computer Vision, Computational Geometry, Machine Learning, Neural Rendering, Generative Models

Education

Ph.D. in Computer Science — Aug 2021-present

University of North Carolina at Chapel Hill — Chapel Hill, NC

Advisor: Stephen M. Pizer

M.S. in Computer Science — Aug 2021-May 2023

University of North Carolina at Chapel Hill, Chapel Hill, NC

Advisor: Stephen M. Pizer

B.A. in Physics and Computer Science — Aug 2017-May 2021

Case Western Reserve University — Cleveland, OH

Specialization: Internet of Things + Medical Image Synthesis

Experience

Graduate Research Assistant — Aug 2021-Present

University of North Carolina at Chapel Hill — Chapel Hill, NC

Advisor: Stephen M. Pizer

- Developed a novel approach to visual navigation, combining deep learning and computational geometry, enabling placement of an endoscope with an accuracy of 3 cm.
- Collaborated with a team to devise and implement a novel, Vision Transformer-based method of monocular depth estimation in the irregular domain of medical endoscopy, achieving competitive or superior performance against existing methods.
- Developed a trainable image-processing pipeline to detect texture-invariant geometric features in endoscopic video, outperforming the state of the art by 30 percentage points on overall accuracy. Optimized this approach to be able to process 110 frames per second.
- Used Qt and VTK to continue development of an interactive post-processing tool for 3D reconstructions.
- Performed extensive testing and debugging on a shared codebase.

Undergraduate Research Assistant — Apr 2020-Aug 2021

Case Western Reserve University — Cleveland, OH

Advisor: Mahdi Bayat

- Developed a novel method, employing deep learning and numerical image processing, to produce images of blood vessels under 1 mm diameter from ultrasound scans without the need for injected contrast agents.
- Introduced a novel method for fast low-rank approximation of spatiotemporal data in applications where speed is prioritized over accuracy. Demonstrated superior performance to comparable, previously-published methods.
- Used MATLAB to implement a blood-vessel simulator to simulate ultrasound scans of a shear-thinning fluid flowing through winding, narrow blood vessels.

Skills

Design: User interface design, Information visualization, Solidworks, Fusion 360, Canva, Illustrator
Programming: Python (NumPy, SciPy, PyTorch, Pytorch3D, OpenCV, Altair, Open3D), Java, C++, MATLAB (Deep Learning Toolbox), Bash, SQL
Hardware: Soldering, Oscilloscope, Logic analyzer, Spectrum analyzer, 3D printer, Laser and waterjet cutter, CNC mill

Graduate Coursework

3D Generative Models, Bioinformatics, Computational Perception, Cryptography, Generative Modeling, Image Processing, Information Visualization, Machine Learning, Neural Rendering, Object Statistics, Shape Representation and Statistics, Vision Transformers

Projects

Shape Viewer — 2024-present

Tool for visualizing the geometric properties of 3D shapes

- Used PyVista, Sympy, and Numpy to to create a cross-platform educational app for visualizing the geometric properties of surfaces.
- This project is an attempt to make an updated, cross-platform version of Shapemonger, an old Windows application that was the only option availabe to visualize surface properties important in differential geometry.
- Features include:
  - visualization of local and global shape properties
  - plotting of Gauss maps and asymptotic spherical maps
  - a customizable plotting system
  - a library of example shape plots highlighting key concepts in differential geometry
- The code is available at https://github.com/qscgy/shape-viewer.

ClubRM — 2023-present

Customer Relations Management for youth organizations

- Implemented from scratch a Customer Relations Management system tailored to youth organizations.
- Wrote a suite of Node.js code that interfaces between several services, facilitating the sharing of knowledge related to organizational activities as well as communication with internal and external audiences.

Outreach & Academic Service

UNC Computer Science Student Association — 2022-present

President — 2023-2024

- Budgeted university funds and coordinated with caterers and facilities services to host biweekly tea times, 4 offsite dinners and 4 lunches for 60 people each, and one family-friendly evening social for 100 people.
- In spring 2024, held 150% more department social events than in any of the previous four semesters.
- Advocated for the views and interests of students during the faculty hiring process as a voting member of the departmental faculty senate.
- Successfully advocated for a cost-of-living increase to graduate student stipends.

Publications & Patents

Ehrenstein, S., McGill, S., Rosenman, J., and Pizer, S. (In review, 2025). Geometric and Photometric Features for Navigation in Colonoscopy.

Paruchuri, A., **Ehrenstein, S.**, Wang, S., Fried, I., Pizer, S.M., Niethammer, M., and Sengupta, R. (2024). Leveraging Near-Field Lighting for Monocular Depth Estimation from Endoscopy Videos. Under review. *arXiv:2403.17915*.

S. Ehrenstein, S.M. Pizer, S. Sengupta, S. Wang, Y. Zhang, J.-M. Frahm (2024). Methods, Systems, and Computer Readable Media for Colonoscopic Blind Spot Detection PCT/US2024/018732. Patent pending.

Ehrenstein, S., McGill, S., Rosenman, J., and Pizer, S. (2023). Scribble-Supervised Semantic Segmentation for Haustral Fold Detection [Lecture]. Presented at Computer Assisted Radiology and Surgery Congress 2023. Munich, Germany.

Zhang, Y., Frahm, J. M., **Ehrenstein, S.**, McGill, S. K., Rosenman, J. G., Wang, S., and Pizer, S. M. (2021). ColDE: A Depth Estimation Framework for Colonoscopy Reconstruction. *arXiv preprint arXiv:2111.10371*.

Ehrenstein, S., Abenojar, E., Perera, R., Exner, A., and Bayat, M. (2021). Rank-Assisted Deep Residual Reconstruction Network for Non-Contrast Ultrasound Imaging of Blood Microvessels. IEEE International Ultrasonics Symposium (IUS). Virtual.

Ehrenstein, S., and Bayat, M. (2021). Deep Learning For Accessible Non-Contrast Ultrasound Imaging of Blood Microvessels. NVIDIA GPU Technology Conference (GTC). Virtual.