Shixuan Gu

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EDUCATION

- **Harvard University**   Cambridge, MA, United States
  Ph.D. in Computer Science   *Sep. 2023 - present*

- **Carnegie Mellon University**   Pittsburgh, PA, United States
  M.S. in Biomedical Engineering - Research   *Sep. 2021 - May. 2023*
  Biomedical Engineering Department Head's Fellowship

- **Shanghai Jiao Tong University**   Shanghai, China
  B.Eng. in Information Engineering - Artificial Intelligence, IEEE Honor Class   *Sep. 2017 - Jun. 2021*
  Outstanding Graduate of Shanghai Jiao Tong University

RESEARCH INTERESTS

My research interest lies in geometric deep learning with applications in biomedical image analysis. My latest research focuses on 3D registration and reconstruction in EM imaging (Connectomics) and CT imaging (rib analysis). I also build robots for competition events and medical usage.

PUBLICATIONS

- **FreSeg: Frenet-Frame-based Part Segmentation for 3D Curvilinear Structures**
  Shixuan Gu, Jason Ken Adhinarta, Mikhail Bessmeltsev, Jiancheng Yang, Yongjie Jessica Zhang, Daniel Berger, Jeff W. Lichtman, Hanspeter Pfister, Donglai Wei
  IEEE Transactions on Medical Imaging (IEEE TMI), 2023, (under review)

- **Biomimetic IGA neuron growth model with neurite morphometric features and CNN-based prediction**
  Kuanren Qian, Ashlee Liao, **Shixuan Gu**, Victoria Webster-Wood, Yongjie Jessica Zhang
  Computer Methods in Applied Mechanics and Engineering (CMAME), 2023

- **RibFrac Challenge: Rib Fracture Detection, Segmentation and Classification from CT Scans**
  Jiancheng Yang*, Rui Shi*, Liang Jin, Xiaoyang Huang, Kaiming Kuang, Donglai Wei, **Shixuan Gu**, Youjun E, Jiaqi Zhang, Jianying Liu, Pengfei Liu, Zhizhong Chai, Yongjie Xiao, Hao Chen, Liming Xu, Bang Du, Xiangyi Yan, Hao Tang, Adam Alessio, Gregory Holste, Jiapeng Zhang, Xiaoming Wang, Jianye He, Lixuan Che, Hanspeter Pfister, Ming Li, Bingbing Ni
  IEEE Transactions on Medical Imaging (IEEE TMI), 2023, (under review)

- ***RibSeg v2*: A Large-scale Benchmark for Rib Labeling and Anatomical Centerline Extraction**
  Liang Jin*, **Shixuan Gu***, Donglai Wei, Jason Ken Adhinarta, Kaiming Kuang, Yongjie Jessica Zhang, Hanspeter Pfister, Jiancheng Yang, Ming Li, Bingbing Ni
  IEEE Transactions on Medical Imaging (IEEE TMI), 2023

- **RibSeg Dataset and Strong Point Cloud Baselines for Rib Segmentation from CT Scans**
  Jiancheng Yang*, **Shixuan Gu***, Donglai Wei, Hanspeter Pfister, Bingbing Ni
  International Conference on Medical Image Computing and Computer-Assisted Intervention (MICCAI), 2021

RESEARCH EXPERIENCE

Visual Computing Group - Harvard University   Cambridge, MA, United States

- ***DenSpineEM*: 3D Dendritic Spine Instance Segmentation from EM Images**
  Advisor: Prof. Hanspeter Pfister, Prof. Donglai Wei, Prof. Jeff Lichtman   *May. 2022 - Apr. 2023*

  ○ Developed the first dendritic spine segmentation benchmark with EM images of mouse somatosensory cortex, mouse visual cortex, and human frontal lobe, respectively.
  ○ Implemented a skeleton-based baseline method to perform dendritic spine segmentation (Dice $\approx 91\%$).
  ○ Proposed a geometric transformation to facilitate deep learning for elongated and curvy objects, such as neurites and blood vessels.

- ***RibSeg v2*: Benchmark for Rib Labeling and Anatomical Centerline Extraction**
  Advisor: Prof. Hanspeter Pfister, Prof. Donglai Wei, Prof. Bingbing Ni   *Jun. 2021 - Jul. 2022*

  ○ Extended *RibSeg* dataset and developed the first large public benchmark for rib labeling and anatomical centerline extraction, including 660 CT cases.
  ○ Proposed 1) a point-based deep learning method for end-to-end rib labeling, 2) a *TEASAR*-based method for rib anatomical centerline extraction, and 3) various metrics for each task to perform comprehensive evaluations.
  ○ Proposed a polyline template alignment-based deep learning method for robust rib anatomical centerline extraction, including *Global Affine* and *Differentiable Upsampling Deformation* blocks.

Computational Bio-Modeling Lab - Carnegie Mellon University — Pittsburgh, PA, United States

- **Neuron Growth Simulation**
  Advisor: Prof. Yongjie Jessica Zhang — *Sep. 2022 - Apr. 2023*
  - Helped implement a CNN-based baseline model, which achieved high simulation accuracy (MRE $\approx 1.19\%$) and efficiency (0.25s/case, $6^{10}\times$ faster than the IGA solver).
  - Helped implement a physics-informed CNN-LSTM, where the loss function was combined with the governing equation of a phase-field model.

- **Study on the Pathogenesis of Alzheimer's Disease and Vascular Cognitive Impairment Using Mouse Models**
  Advisor: Prof. Yongjie Jessica Zhang, Prof. Kanekiyo Takahisa — *Oct. 2022 - Jan. 2023*
  - Collaborated with Mayo Clinic to study the differences in brain vascular structure between different mouse groups.
  - Tested VesSAP on CT images of mouse brain to segment brain and reconstruct vasculature.
  - Implementing transfer learning-based method to generalize VesSAP to data from Mayo Clinic.
  - Computing vessel density, length, and size of the segmented vascular structures for comparison between several mouse groups such as male vs. female mice, and young vs. aged mice.

Biorobotics Lab - Carnegie Mellon University — Pittsburgh, PA, United States

- **Robotic Ventilator: Patient Care Technologies for Permanent Ambulatory Artificial Lung Support**
  Advisor: Prof. Howie Choset, Prof. Keith E. Cook, Prof. Jason J. Rose — *Sep. 2021 - Aug. 2022*
  - Collaborated with the University of Pittsburgh Medical Center (UPMC) to design and build a portable oxygen concentrator prototype for ICU ventilation.
  - Designed and built a clinical ventilation sensor for breathing data collection and interaction with an online database.
  - Collected synthetic breathing signals with artificial lungs, and developed a deep learning-based alarming system for lung-related diseases such as hyperinflation.

Vision and Learning Lab - Shanghai Jiao Tong University — Shanghai, China

- **RibSeg Dataset and Strong Point Cloud Baselines for Rib Segmentation from CT Scans**
  Advisor: Prof. Bingbing Ni — *Oct. 2020 - Jun. 2021*
  - Developed *RibSeg*, the first public large-scale dataset, including 490 CT scans (11,719 individual ribs), for rib segmentation to enable downstream applications and method comparison.
  - Proposed a point cloud-based method to segment ribs from CT scans, which achieves high accuracy (Dice $\approx 95\%$) and efficiency ($40\times$ faster than prior arts).

Intelligent Robot Lab - Shanghai Jiao Tong University — Shanghai, China

- **VEX Robotics Project: VEX U Robotics World Tournaments**
  Advisor: Prof. Chuntao Leng — *Sep. 2018 - May. 2020*
  - Co-founded the SJTU VEX Lab, and won the first VEX robotics world championship for SJTU.
  - Designed and built the ejection structure crossbow, trebuchet, and flywheel for three prototypes, respectively.
  - Designed the scoring path and programmed control codes for the automation stage of the competition.

AWARDS

- **[2019] VEX U Skills Challenge World Champion, VEX U Division Champion, and World Finalist**
  2019 VEX U Robotics World Championship, Robotics Education & Competition Foundation

- **[2018] Create Award, Robot Skills Finalist, Silver Award**
  2018 12th Asia-Pacific Robotics Championship, Asian Robotics League

- **[2018] Nomination for Excellence Award, Amaze Award, Tournament Semifinalists**
  2018 China National VEX Robotics Competition

- **[2018] Student Ambassador, Excellent Student Presentation Award**
  2018 Student Learning Festival of C9+1 Symposium, The University of Hong Kong

- **[2016] First Prize, Best Con in Shanghai International Young Physicists' Tournament (IYPT Shanghai)**
  Shanghai Physical Society, China

MISCELLANEOUS

- **Programming**: Python (PyTorch, scikit-learn, NumPy, Pandas), C++, Javascript, HTML, MATLAB.
- **Robotics**: Proficient in VEX robot design, RobotC, SolidWorks.
- **Tools**: ITK, MySQL, CyberTorcs, Neuroglancer.
- **Teaching Assistant**: UCLA Extension (Shanghai Pinghe) - Artificial Intelligence and Data Science (COM SCI - 960.01: Aug'21), Research Methodologies (ENGL 902: Aug'21), Academic Writing (ENGL 901: Aug'21).