

Shixuan Gu

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EDUCATION

- Carnegie Mellon University** Pittsburgh, PA, United States
M.S. in Biomedical Engineering - Research Sep. 2021 - Present
Biomedical Engineering Department Head's Fellowship
- Shanghai Jiao Tong University** Shanghai, China
*B.Eng. in Information Engineering and 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 electron microscopy imaging (Connectomics) and CT imaging (rib analysis). I also build robots for competition events and medical usage.

PUBLICATIONS

- RibSeg v2: A Large-scale Benchmark for Rib Labeling and Anatomical Centerline Extraction**
Liang Jin*, **Shixuan Gu***, Donglai Wei, Kaiming Kuang, Hanspeter Pfister, Bingbing Ni, Jiancheng Yang, and Ming Li
IEEE Transactions on Medical Imaging (IEEE TMI), 2022 (under review)
[\[preprint\]](#)
- FreNet Frame: A Skeleton-based Method for Segmentation of Elongated Objects**
Shixuan Gu, Jason Ken Adhinarta, Hanspeter Pfister, Jeff W. Lichtman, Donglai Wei
IEEE Transactions on Medical Imaging (IEEE TMI), 2022 (manuscript)
- Modeling Neuron Growth Process Using Physics-informed Convolutional Neural Network**
Kuanren Qian, Ashlee Liao, **Shixuan Gu**, Victoria Webster-Wood, Jessica Zhang
Scientific Reports, 2022 (in submission)
- 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
[\[paper\]](#) [\[code\]](#) [\[dataset\]](#) [\[poster\]](#)

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 - Present
 - 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%).
 - Working on coordinate transformation for general curvy structures and test on intracranial aneurysm segmentation.
 - Paper **FreNet Frame: A Skeleton-based Method for Segmentation of Elongated Objects** is targeted for IEEE TMI 2022.
- RibSeg v2: Benchmark for Rib Labeling and Anatomical Centerline Extraction**
Advisor: Prof. Hanspeter Pfister, Prof. Donglai Wei, Prof. Bingbing Ni Jun. 2021 - Jul. 2022
 - Extend *RibSeg* dataset and develop 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.
 - Paper **RibSeg v2: A Large-scale Benchmark for Rib Labeling and Anatomical Centerline Extraction** submitted to IEEE TMI 2022 is under review.
 - Proposed a polyline template alignment-based deep learning method for robust rib anatomical centerline extraction, including *Global Affine* and *Differentiable Upsampling Deformation* blocks.
 - Paper **Ribbon: Template Alignment-based Rib Anatomical Centerline Extraction from CT Scans** is targeted for MICCAI 2023.

Computational Bio-Modeling Lab - Carnegie Mellon University

Pittsburgh, PA, United States

- **Study on the Pathogenesis of Alzheimer's Disease and Vascular Cognitive Impairment Using Mouse Models**
Advisor: Prof. Jessica Zhang, Prof. Kanekiyo Takahisa *Oct. 2022 - Present*
 - Collaborate with Mayo Clinic on studying the differences in brain vascular structure using CT images via 1) assessing brain segmentation and 3D reconstitution of vasculature, and 2) analyzing vessel density, length, and size based on CT images.
- **Neutron Growth Simulation**
Advisor: Prof. Jessica Zhang, Prof. Victoria Webster-Wood *Sep. 2022 - Present*
 - Proposed physics-informed neural network for partial differential equation (PDE) equation to speed up the simulation of the growth of neurons.
 - Paper *Modeling Neuron Growth Process Using Physics-informed Convolutional Neural Network* is targeted for Scientific Reports 2022.
 - Paper *Multi-stage Neurite Tracer Detection for Rat Hippocampal Neuron Morphogenesis Analysis* is targeted for MICCAI 2023.

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 UPMC to design and build a portable O₂ concentrator for ICU ventilation.
 - Designed and built a clinical ventilation sensor for breathing data collection and interaction with an online database.
 - Drafted research proposal focusing on machine learning-based alarm system for STTR program at NSF.
 - Developed a deep learning-based alarming system for lung-related disease such as hyperinflation, and built an online database for breathing data.

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, Prof. Donglai Wei, Prof. Hanspeter Pfister *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 an efficient point-based model to segment ribs, which converts dense CT volume into sparse point clouds, and produces high-quality rib segmentation (Dice \approx 95%) with significant efficiency (40 \times faster than prior arts).
 - Paper *RibSeg Dataset and Strong Point Cloud Baselines for Rib Segmentation from CT Scans* is accepted by MICCAI 2021.

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, 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.

PROJECTS

- **Simulated evaluation of automatic control methods for vehicles:** implemented control methods, including PID, MPC, and FLC, and evaluated their performance for intelligent vehicles through simulations on CyberTorcs.
- **Batch QR code scanning for mobile devices:** built a complimentary system to enable batch QR code scanning on mobile devices, with an online CNN-based method and offline DIP-based method.
- **Machine learning-based vehicle localization and mapping:** developed machine learning-based methods for vehicle localization and mapping under complex environments.

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, etc.
- **Robotics:** Proficient in VEX robot design, RobotC, SolidWorks.
- **Tools:** ITK, MySQL, CyberTorcs.
- **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).