Xuzhe Zhang

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EDUCATION

Columbia University, New York, US

Ph.D. in Biomedical Engineering 2020 - now
Advisor: Andrew F. Laine, D.Sc.

M.S. in Biomedical Engineering 2018 - 2019
Advisor: Andrew F. Laine, D.Sc.

University of California, Riverside, US

Exchange Student in Bioengineering 2017

Northeastern University, Shenyang, China

B.Eng. in Biomedical Engineering 2014 - 2018

RESEARCH INTERESTS

I am interested in studying AI-empowered biomedical imaging acquisition, processing, and interpretation to transform medical research and clinical practice. My research is multidisciplinary, building on techniques in ***deep learning***, ***computer vision***, and ***biomedical imaging*** to design and deploy open-source frameworks in medical / clinical research communities, with the goal of assisting large-scale and cross-modality clinical studies to discover quantitative image-based markers and thereby improve healthcare.

Recently, I have focused on **self-supervised learning** and **domain adaptive segmentation**.

SELECTED PROJECTS

Robust infant brain MRI segmentation through human-inspired self-supervised learning
Supervisors: Andrew F. Laine, D.Sc., Yun Wang, Ph.D. (Duke), and Jonathan E. Posner, M.D. (Duke)

- Developing a framework that provides robust segmentation for heterogeneous infant brain structural MRI data (e.g., acquired at different ages, acquired from diverse scanners with different sequences and magnetic field strengths).
- Significantly improved model's generalization through self-supervised learning with 3D masked autoencoders and pretext tasks that reflect radiologists' reasoning when interpreting the scan.
- A cloud-version framework and frontend website are under development.
- Ongoing

Completing missing and corrupted scans: cross-modality image synthesis for infant brain MRI [3]
Supervisors: Andrew F. Laine, D.Sc., Yun Wang, Ph.D. (Duke), and Jonathan E. Posner, Ph.D. (Duke)

- Developed a new transformer-based 3D model (PTNet3D) for high-resolution and longitudinal infant brain MRI cross-modality synthesis (i.e., T1w-T2w, T2w-T1w).
- PTNet3D used a simplified attention mechanism during encoding/decoding and reduced the quadratic complexity of the original full-rank attention.
- PTNet3D synthesized more realistic MRI scans compared to previous models (e.g., pix2pix, pix2pixHD, StarGAN).
- When there are 25% corrupted scans (with motion artifacts), replacing them with PTNet3D-synthesized scans decreased the average surface distance and 95% Hausdorff distance between segmented and ground truth masks by 64%, close to the results of segmenting good scans.

Full lung segmentation on MRI acquired from different sequences via adversarial domain adaptation
Supervisors: Wei Shen, M.D. (Columbia Medical Center), Elsa D. Angelini, Ph.D. (Imperial College & Columbia), and Andrew F. Laine, D.Sc.

- Improved full lung segmentation on different MRI sequences via adversarial domain adaptation based on entropy map.
- Reduced the absolute error in segmented lung volume by 68%.
- 3D version and similar framework for cross-modality (CT-MRI) pulmonary airway segmentation is working in progress

Quantification of lung ventilation on hyperpolarized gas MRI using deep learning [1]
Supervisors: Andrew F. Laine, D.Sc., Wei Shen, M.D. (Columbia Medical Center), and Elsa D. Angelini, Ph.D. (Imperial College & Columbia)

- Designed a GAN-based framework to synthesize hyperpolarized (HP) helium gas MRI (highly expensive and time-consuming to acquire).
- Designed a cascaded UNet to improve segmentation on multi-categorical ventilation segmentation on HP MRI.

Detection and classification of lung nodules on CT
Undergrad Thesis Advisor: Zhiqiong Wang, Ph.D. (Northeastern University, China)

- Designed an end-to-end MATLAB-based program for fully automatic lung nodule detection and classification on pulmonary CT images, utilizing several image processing algorithms for candidate nodule extraction and applying SVM on hand-crafted features for classification.

HONORS & AWARDS

Annual Northeastern University Scholarship 2015 - 2016 & 2016 - 2017
Sino-Dutch Biomedical and Information Engineering School Scholarship 2015 - 2016

PUBLICATIONS

Peer-reviewed journal articles:

1. **X. Zhang**, E. D. Angelini, F. S. Haghpanah, A. F. Laine, Y. Sun, G. Hiura, S. Dashnaw, M. Prince, E. A. Hoffman, B. A. Venkatesh, J. A. Lima, J. M. Wild, E. W. Hughes, R. G. Barr, and W. Shen, "*Quantification of lung ventilation defects on Hyperpolarized MRI: the Multi-Ethnic Study of Atherosclerosis (MESA) COPD Study*," in Magnetic Resonance Imaging, 2022. link
2. Y. Wang, F. S. Haghpanah, **X. Zhang**, K. Santamaria, G. K. da Costa Aguiar Alves, E. Bruno, N. Aw, A. Maddocks, C. S. Duarte, C. Monk, A. Laine, and J. Posner, "*ID-Seg: An Infant Deep Learning-Based Segmentation Framework to Improve Limbic Structure Estimates*," in Brain Informatics, 2022. link
3. **X. Zhang**, X. He, J. Guo, N. Ettehadi, N. Aw, D. Semanek, J. Posner, A. Laine, and Y. Wang, "*PTNet3D: A 3D High-Resolution Longitudinal Infant Brain MRI Synthesizer Based on Transformers*," in IEEE Transactions on Medical Imaging, 2022. link
4. X. He, E.-L. Tan, H. Bi, **X. Zhang**, S. Zhao, and B. Lei, "*Fully transformer network for skin lesion analysis*," in Medical Image Analysis, 2022. link
5. N. Ettehadi, P. Kashyap, **X. Zhang**, Y. Wang, D. Semanek, K. Desai, J. Guo, J. Posner, and A. F. Laine, "*Automated Multiclass Artifact Detection in Diffusion MRI Volumes via 3D Residual Squeeze-and-Excitation Convolutional Neural Networks*.," in Frontiers in Human Neuroscience, 2022. link

Conference abstracts / papers:

6. N. Ettehadi, **X. Zhang**, Y. Wang, D. Semanek, J. Guo, J. Posner, and A. F. Laine, "*Automatic*

Volumetric Quality Assessment of Diffusion MR Images via Convolutional Neural Network Classifiers," in 2021 43rd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC), 2021. link

7. N. P. Taskiran, G. T. Hiura, **X. Zhang**, S. M. Dashnaw, E. A. Hoffman, D. Malinsky, E. C. Oelsner, M. R. Prince, B. M. Smith, Y. Sun, Y. Sun, J. M. Wild, W. Shen, R. G. Barr, and E. W. Hughes, "Estimation of the Alveolar Partial Pressure of Oxygen using Hyperpolarized Helium-3: The Multi-Ethnic Study of Atherosclerosis (MESA) COPD Study," in European Respiratory Journal, vol. 58, no. suppl 65, 2021. link
8. *(Oral)* **X. Zhang**, E. Angelini, A. Laine, Y. Sun, G. Hiura, S. Dashnaw, M. Prince, E. Hoffman, B. Ambale-Venkatesh, J. Lima, J. Wild, E. Hughes, R. G. Barr, and W. Shen, "*Ventilation defect quantification on 3He MRI through deep learning: the MESA COPD Study*," in European Respiratory Journal, vol. 56, no. suppl 64, 2020. link
9. G. Hiura, **X. Zhang**, Y. Sun, M. Prince, S. Dashnaw, J. Wild, E. Hughes, W. Shen, and E. Oelsner, "*Reproducibility of 3He-MRI acquisition assessed by a deep learning approach: ventilation defects in the VaPE-Tox pilot study*," in European Respiratory Journal, vol. 56, no. suppl 64, 2020. link

Preprints:

10. X. He, J. Guo, **X. Zhang**, H. Bi, S. Gerard, D. Kaczka, A. Motahari, E. Hoffman, J. Reinhardt, and R. G. Barr, "*Recursive Refinement Network for Deformable Lung Registration between Exhale and Inhale CT Scans*," arXiv preprint arXiv:2106.07608, 2021. link
11. **X. Zhang**, X. He, J. Guo, N. Ettehadi, N. Aw, D. Semanek, J. Posner, A. Laine, and Y. Wang, "*PTNet: a high-resolution infant MRI synthesizer based on transformer*," arXiv preprint arXiv:2105.13993, 2021. link

TEACHING EXPERIENCE

Teaching Assistant

BMEN 4460 Deep Learning in Biomedical Imaging — Spring 2022

PRESENTATIONS

Conference

- "*Ventilation defect quantification on 3He MRI through deep learning: the MESA COPD Study*" European Respiratory Society International Congress, Remote, September 2020

Guest Lecturer

- "*PTNet: Avoiding Data Loss for Infant Brain Structural MRI via Pyramid Transformer Network*" BMEN 4460 Deep Learning in Biomedical Imaging, Columbia University, April 2022

SERVICE

Challenge Organization

2021, IEEE COVID-19 Imaging Informatics Challenge, IEEE Healthcare Summit

SKILLS

Data Science: MATLAB, Python
Medical Image Analysis: ANTs, ITK, TorchIO, 3D Slicer
Shape/surface Analysis: SlicerSALT, MeshLab
Deep Learning: PyTorch, TensorFlow
Others: OpenCV, Cloud Computing (AWS & AWS SageMaker, GCP), C/C++ (limited)