Gang Yang

Medical Image Processing •Inverse Problems •Low-level Vision

18224493738 yg1997@mail.ustc.edu.cn yggame

University of Science and Technology of China (USTC) Ph.D. student

May 28, 1997 Lianyuan•Hunan

Ph.D. candidate at **National Engineering Laboratory for Brain-inspired Intelligence Technology and Application (NEL-BITA)**, University of Science and Technology of China (USTC), advised by Prof. Feng Wu, Prof. Xun Chen, and Associate Prof. Aiping Liu. Possess a strong research and mathematical foundation, with a keen interest in AI for science, generative models, and interpretable models.

Education

Present	Department of Electronic Engineering and Information Science, **University of Science and Technology of China (USTC)**, Ph.D. in Information and Communication Engineering
September 2019	Course: Statistical Learning, Digital Image Analysis, Image Understanding
June 2019	College of Electronic Information, **Sichuan University**, bachelor in Electronic Information Engineering
September 2015	Course: Advanced Mathematics, Linear Algebra, Signal Processing

Research Experience

- Model-based Super-resolution Reconstruction (Pan-sharpening)
  - Most existing Pan-sharpening methods are designed in a **black-box** principle without considering the rationality of models, lacking sufficient interpretability.
  - They ignore the different characteristics of each band of MS images and directly concatenate them with panchromatic (PAN) images, leading to severe copy artifacts.
  - We propose an interpretable deep neural network, namely **MDCUN**. Considering the degradation process, it formulates the Pan-sharpening problem as the minimization of a variational model with denoising based prior and non-local auto-regression prior and a novel iteration algorithm with builtin CNNs is exploited for transparent model design. To fully explore the potentials of different bands of MS images, the PAN image is combined with each band of MS images, selectively providing the high-frequency details and alleviating the copy artifacts.
  - Research achievement: Relevant work accepted by **CVPR 2022**.
- Model-based Super-resolution Reconstruction (Multi-Contrast MRI Super-resolution)
  - Most existing super-resolution (SR) reconstruction network are designed in a **black-box** principle, thus lacking sufficient interpretability and further limiting their practical applications. Interpretable neural network models are of significant interest since they enhance the trustworthiness required in clinical practice when dealing with medical images.
  - Most existing SR reconstruction approaches only use a single contrast or use a simple multi-contrast fusion mechanism, neglecting the complex relationships between different contrasts that are critical for SR improvement.
  - We propose a novel **Model-Guided interpretable Deep Unfolding Network** (**MGDUN**) for medical image SR reconstruction. Leveraging the domain knowledge of MRI SR and enhancing reconstruction performance, the Model-Guided image SR reconstruction approach solves manually designed objective functions to reconstruct HR MRI. It unfold an iterative MGDUN algorithm into a novel model-guided deep **unfolding** network by taking the MRI observation matrix and explicit multi-contrast relationship matrix into account during the end-to-end optimization.
  - Research achievement: Relevant work accepted by **ACMMM2022**.
- Generative Super-resolution Reconstruction

  - Pan-sharpening essentially inherits the **ill-posed nature** of the super-resolution (SR) task that diverse HRMS images can degrade into an LRMS image and existing deep learning-based methods ignore the diversity of the HRMS image.
  - Existing CNN-based methods can obtain excellent results, but they only learn a deterministic mapping from LRMS and PAN images to HRMS images, and thus the ill-posed issue is not well addressed.
  - we propose a novel neural architecture for pan-sharpening, called **PanFlowNet**, which directly learns the **conditional distribution** of the HRMS image given the input LRMS image and PAN image instead of learning a **deterministic mapping**. And we follow the design of the **Probabilistic Flow Model** to produce an invertible neural network (INN) with Conditional Affine Coupling Blocks (CACBs).
  - Research achievement: Relevant work accepted by **ICCV 2023**.
- Medical image segmentation (in progress...)
  - The CNN-based methods representing image features through local convolution operation often involve many parameters and are limited in obtaining adequate global and long-range semantic information, resulting in high computational costs and leading to insufficient interpretation.
  - As the process of segmentation is essentially an ill-posed problem, CNNs **over-compress or discard** the learned features during layer-by-layer propagation. Information loss and over-compression of the model in CNNs are barely considered at later stages, leading to degraded segmentation performance.
  - We propose a novel **graph convolutional invertible neural network (GINN)** for multi-organ medical image segmentation. **GINN** combines **the feature extraction capabilities of graph convolution** with **the feature fusion provided by invertible modules**, improving segmentation performance.
  - Submitted to the IEEE Journal of Biomedical and Health Informatics (Patent granted).
- Reviewers: CVPR, ACM MM, PRCV, CICAI, etc.

Research Achievements

- **Gang Yang**, Man Zhou, Keyu Yan, Aiping Liu, Xueyang Fu, Fan Wang. Memory-augmented deep conditional unfolding network for pan-sharpening[C]//Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. 2022: 1788-1797.
- **Gang Yang**, Li Zhang, Man Zhou, Aiping Liu, Xun Chen, Zhiwei Xiong, Feng Wu. Model-Guided Multi-Contrast Deep Unfolding Network for MRI Super-resolution Reconstruction[C]//Proceedings of the 30th ACM International Conference on Multimedia. 2022: 3974-3982.
- **Gang Yang**, Xiangyong Cao, Wenzhe Xiao, Man Zhou, Aiping Liu, Xun Chen, Deyu Meng. PanFlowNet: A Flow-Based Deep Network for Pan-sharpening[J]. arXiv preprint arXiv:2305.07774, 2023.(ICCV 2023)
- Man Zhou, Xueyang Fu, Zeyu Xiao, Aiping Liu, **Gang Yang**, Zhiwei Xiong. Unfolding Taylor's Approximations for Image Restoration[J]. Advances in Neural Information Processing Systems, 2021, 34: 18997-19009.
- Man Zhou, Jie Huang, Keyu Yan, **Gang Yang**, Congyi Li, Feng Zhao. Normalization-based feature selection and restitution for pan-sharpening[C]//Proceedings of the 30th ACM International Conference on Multimedia. 2022: 3365-3374.

Research Results Under Submission

- **Gang Yang**, Aiping Liu, Xueyang Fu, Zhiwei Xiong, Xun Chen, Feng Wu. GINN: Graph-Convolutional Invertible Neural Network for Medical Image Segmentation[J]. Submitted to IEEE Journal of Biomedical and Health Informatics.
- **Gang Yang**, Li Zhang, Man Zhou, Aiping Liu, Xun Chen, Zhiwei Xiong, Feng Wu. MGDUN: An Interpretable Network for Multi-Contrast MR Image Super-Resolution Reconstruction[J]. Submitted to Computers in Biology and Medicine.

Awards & Honors

- **First-class Academic Scholarship** from the University of Science and Technology of China.

- **Outstanding University Graduate** in Sichuan Province, Outstanding Graduate of Sichuan University, and Excellent Student.
- **First Prize** in the Non-Mathematics Category at the 8th National College Student Mathematical Contest.
- **National Scholarship**, National Inspirational Scholarship, Comprehensive Excellence Scholarship.

In-School Experiences

- Deputy Minister of the Human Resources Department, Graduate Student Union. Participated in various projects and activities organized by the Graduate Student Union, such as recruitment events in autumn and spring, as well as the "Beautiful Encounter" team. Served as the Head of the Sports Field area in the "Beautiful Encounter" event and was awarded the "Project Star" recognition.
- Deputy Minister of the Executive Department, Tengfei Youth Volunteer Service Team.

Competences & Languages

Programming	Python, C, C++, Matlab
Deep learning	Pytorch (conversant), TensorFlow, Keras (understand)
Others	SSH, Tmux, Office, Photoshop...