Mingrui Liu (Matthew)

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EDUCATION

Nanjing University of Posts and Telecommunications (NJUPT)   09/2018 - 06/2022
- Bachelor of Engineering (B.Eng.), Optoelectronic Information Science and Engineering
- **GPA: 4.20/5.0; Ranking: 9/269 (Top 3%)**

PROJECTS

CNN-based Diagnosis of COVID-19: A Comparative Study on Different Image Preprocessing Methods

Mentor: Munib Wober, Visiting Lecturer, Harvard, Cambridge   05/2021 - 08/2021

Most researches changed the structure and parameters of neutral network for a better performance in the diagnosis of COVID-19 Pneumonia. Our project mainly focused on figuring out the best preprocessing method to help diagnosing COVID-19.

- Studied different preprocessing methods; learned basic concepts of filtering and transformation in the frequency domain, including the use of Wiener filter and Discrete Cosine Transform (DCT).
- Designed two preprocessing methods which used different algorithms to enhance or reduce the noise and resize original images; compared the strengths and weaknesses of these two methods.
- Evaluated the result of classification accuracy of our neutral network with two different preprocessing methods.
- Disclosed a conference paper.

Core-Project: Image Reconstruction based on Digital Breast Tomosynthesis   02/2020 - 05/2021
(DBT)

Key Laboratory of Image Processing and Image Communication of Jiangsu Province, NJUPT
Mentor: Assoc. Prof. Chunyu Yu (yucy@njupt.edu.cn)

Currently, the mainstream researches on DBT reconstruction are mostly based on FBP Algorithm and Algebraic Reconstruction Technique, but they seldom involve SAA (Shift And Add). Our project took an innovative approach to improve the SAA by adding the Blind Source Separation method. The experimental result showed that the improved SAA has advantages over the quality reconstruction slice, the conservation of detail information, and the authenticity and integrity of artifacts control and imaging.

- Conducted literature review to learn about the DBT reconstruction algorithm; Successfully reproduced SAA in the research paper by carrying out its theoretical derivation and coding in MATLAB.
- Looked up and ascertained the parameters of experimental instruments and apparatus structures.
- Ran different algorithms, including FBP, MLEM, and SART, to compare their strengths and weaknesses, calculated the distinctions between them and SAA.
- Calculated the evaluation index parameters upon our improvements on SAA.
- Disclosed two invention patents.

Sub-Project: Digital Mammogram Image Enhancement based on Guided Image Filtering and Histogram Equalization   05/2021 – 07/2021
Mentor: Assoc. Prof. Chunyu Yu (yucy@njupt.edu.cn)

In this sub-project, we proposed a digital mammogram enhancement algorithm based on Guided Image Filtering. Compared to the traditional method CLAHE, the results of our experiment showed that our algorithm has a better performance: it increases Enhancement Measure Evaluation by 41%, Spatial Frequency by 40%, and Edge Content and resolution by 52%.

- Conducted literature review to learn about different enhancement methods for mammogram images; Studied different traditional methods related to histogram equalization, including HE, AHE, BBHE, and CLAHE.
- Designed an innovative method that used Guided Image Filtering and a morphological transformation to enhance mammogram images.
- Calculated the evaluation index parameters upon our improvements on CLAHE.
- Disclosed a conference paper.

Mammogram Image Classification based on Transfer Learning 01/2020 - 03/2020
Mentor: Jiang Yue, Doctoral Candidate, Hohai University, Nanjing

In this project, we applied a method that used transfer learning to distinguish benign and malignant breast tumors. ResNet18 network structure and ImageNet dataset were used to pre-train the model, and the MIAS dataset was added to the last layer to train the parameters.

- Studied fundamental machine learning techniques, including KNN, NN, and SVM, and familiarized with the classic machine learning models, including linear regression, logic regression, neural network, PCA, unsupervised learning, etc.
- Ran MNIST and CIFAR examples using MatConvNet, a MATLAB toolbox implementing Convolutional Neural Networks (CNNs) for computer vision applications.
- Performed a segmentation experiment to distinguish benign and malignant breast tumors using transfer learning in the PyTorch environment, GoogleNet network structure, and MIAS dataset.
- Comprehended network structures, e.g., LeNet5 and AlexNet, as well as neural network concepts.

Image Segmentation based on MATLAB and Deep Learning 10/2019 - 12/2019
Mentor: Prof. Zhengmeng Jin (jinzhm@njupt.edu.cn)

- Read about the applications of MATLAB in image analysis and familiarized myself with the fundamental image manipulation in MATLAB, including 2D Plots, pie charts, and bar charts.
- Ran MATLAB codes and observed the effects of different types of image manipulation.
- Learned various image segmentation methods, e.g., the histogram threshold segmentation method, the OTSU method, the Watershed algorithm, and ran code examples in MATLAB.
- Applied MATLAB to experiment on selected images, observed the images, summarized the pros and cons of each different segmentation method.
- Studied the applications of U-Net, KNN, and semantic segmentation in image segmentation, and learned about NumPy and mainstream deep learning platforms.

PUBLICATIONS

- **Liu, M.**, Li, H., Sun N., Yu, C., *Digital Mammogram Image Enhancement based on Guided Image Filtering and Histogram Equalization*. [Accepted by 2021 China Biomedical Engineering Conference & Medical Innovation Summit. Expected to give an oral presentation];
- **Liu, M.**, Cui, Y., Ding, J., Liu, X., *CNN-based Diagnosis of COVID-19: A Comparative Study on Different Image Preprocessing Methods.* [Accepted by 2021 2nd International Seminar on Artificial Intelligence, Networking and Information Technology (AINIT 2021). Expected to be published on IEEE CPS];
- **Liu, M.**, Li, H., Yu, C., *Digital Breast Tomosynthesis Image Reconstruction based on Weight Adjust Second Order Blind Identify.* [In modification. Expected to be submitted to Review of Scientific Instruments].

PATENTS

- Yu, C., Li, H., **Liu, M.**, Chen, G. (2020). *The Reconstruction Method of the Synthetic Photography of Digital Breast Tomosynthesis (DBT) based on Weight-Adjusted Second-Order Blind Identification.* (2020106680165).
- Yu, C., Li, H., Chen, G., **Liu, M.** (2020). *The Reconstruction Method of the Synthetic Photography of Digital Breast Tomosynthesis based on Non-parameter Kernel Density Estimation.* (2020109778216).

HONORS AND AWARDS

First Prize, Jiangsu Contemporary Undergraduate Mathematical Contest in Modeling **(Top 1.5%)** 11/2020
First Class Scholarship, NJUPT **(Top 3%)** 08/2020
Second Prize, May Day Mathematical Contest in Modeling **(Top 1.5%)** 06/2020
Meritorious Winner, Interdisciplinary Contest in Modeling 04/2020
National scholarship, Ministry of Education of PRC **(Top 0.3%)** 12/2019
First Class Scholarship, NJUPT **(Top 3%)** 12/2019

ADDITIONAL

Standardized Tests: TOEFL 107 (R28/L28/S23/W28); GRE Quantitative 96% + Verbal 75%
Programming: C (2yrs), MATLAB (2yrs), Python (1yr), SPSS (1yr), Lingo (1yr)
Hobbies: GO (Chinese WeiQi)