Kuan Huang

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Personal Statement

I received my Ph.D. degree in the Department of Computer Science at Utah State University. I obtained my bachelor's degree from Harbin Institute of Technology (HIT). Now, I am an Assistant Professor at Department of Computer Science and Technology, Kean University, Union, NJ, USA. My major research field is medical image analysis, deep learning, and machine learning.

Research Interests

Computer Vision, Deep Learning, Pattern Recognition, Medical Image Analysis, Fuzzy Logic

Education

Utah State University (USU) — Logan, UT
Ph.D. in Computer Science. GPA: 3.98/4.00, Best Dissertation Award — *Aug. 2016 – May 2021*
Supervisor: Dr. Heng-Da Cheng
Dissertation: Breast Ultrasound Image Segmentation Based on Uncertainty Reduction and Context Information

Harbin Institute of Technology (HIT) — Harbin, China
B.Eng. in Measurement Control Technique & Instruments. GPA: 3.78/4.0 — *Sep. 2012 – Jun. 2016*
Thesis topic: Estimating Lithium-ion Batteries State of Health (SOH) Using Particle Filter

Professional Work Experience

Assistant Professor
Kean University — *Union, USA, Sep. 2022-Present*

Post-doctoral Researcher
Baylor College of Medicine — *Houston, USA, May 2021-Aug. 2022*

Teaching Assistant
Utah State University — *Logan, USA, Aug. 2016-May 2021*

Teaching

Assistant Professor — Kean University
CPS2231: Computer Programming (Java Programming) — *Fall 2022 - Spring 2023*
CPS4801: Artificial Intelligence — *Spring 2023*
CPS5801: Advanced Artificial Intelligence — *Spring 2023*
CPS4802: Machine Learning Algorithms — *Fall 2022*
CPS5802: Machine Learning Innovations — *Fall 2022*

Teaching Assistant — Utah State University
CS2810: Computer Systems Organization and Architecture — *Fall 2016, Spring 2020, Fall 2020, Spring 2021*
CS5050: Advanced Algorithms — *Fall 2017 – Fall 2019*
CS1410: Introduction to C++ — *Spring 2017*

Lab Instructor — Utah State University
CS1400: Introduction to Python — *Summer 2019*

Research Experience

My research interests focus on improving deep learning algorithms and applying deep learning approaches to breast ultrasound (BUS) images and pathology images.

1. **Breast Ultrasound Image Segmentation:**
   In this research project, I developed novel deep learning architectures for breast ultrasound image segmentation using fully convolutional networks (FCN), conditional random fields (CRFs), fuzzy logic, connectedness theory, etc. There are seven major parts in this section:

- **Fuzzy deep convolutional neural network:** Uncertainty and noise were reduced by fuzzy logic in position and channel dimension. The feature map was resized to different resolutions to reduce uncertainty by a pyramid fuzzy uncertainty reduction block. The proposed methods achieved improvements compared with state-of-the-art methods on a dataset with 325 images and a public dataset.
- **Involving breast anatomy in segmentation:** (1) The theory of connectedness and recurrent neural network were used to compute the connectedness between each pixel and boundary pixels in the horizontal and vertical directions, which was defined as direction-connectedness (DC) feature. The DC feature could reflect the breast anatomy. DC feature was added to our fuzzy deep learning architecture for BUS image and outperformed eight state-of-the-art deep learning methods. (2) Medical knowledge constrained CRFs were proposed, which applied the BUS image layer structure as the new pairwise term in the energy function of CRFs.
- **Shape-adaptive convolutional operator:** A novel convolutional operator whose shape was decided based on selection of convolutional pixels was proposed. The selection was based on feature values or self-attention coefficients. The novel convolutional operator could involve higher order information rather than in Euclidean domain.
- **Breast ultrasound image classification:** A novel Gaussian Mixture Model (GMM) with neutrosophic logic is designed to classify benign and malignant breast tumors. Two neutrosophic logic components are applied to the likelihood function of GMM to reduce the effectiveness of uncertain and noisy samples. The second research is about a novel deep learning method for breast ultrasound image BI-RADS category classification.
- **Generative adversarial networks for segmentation:** A novel architecture for breast ultrasound image segmentation is developed based on generative adversarial networks (GANs). A fuzzy logic-based module is proposed to increase the non-linearity and discriminability of GANs. Moreover, the structure and loss function of the discriminative network are re-designed for increasing breast ultrasound image segmentation accuracy.
- **Interpretability of convolutional features in medical images:** Deep learning methods achieve high performance in medical imaging applications such as disease diagnosis and lesion detection. However, the success of deep learning approaches is depended on the automatically trained convolutional features. Convolutional features are like a "black box" and rarely use prior knowledge and user interactions, which limits the usage and robustness of the deep learning methods. In this research project, we investigate the importance of different regions and different channels of convolutional features. Also, we use prior medical knowledge to improve the robustness of existing deep-learning methods.
- **Active learning in medical images:** Acquiring medical images and their segmentation labels is often time-consuming and labor-intensive. Compared to natural images, medical images need to be screened and annotated by professional doctors in segmentation tasks, especially those containing multiple organ tissues. To reduce the workload of doctors, we propose deep active learning-based frameworks for medical image segmentation.

2. **Pathology Image Analysis:**

   - **Image style translation in pathology image:** Immunohistochemistry (IHC) staining images and hematoxylin and eosin (H&E) staining images are important pathology image styles. The use of IHC staining is limited due to more complex laboratory processing and high-cost. In this project, generative adversarial networks (GANs) are utilized to generate fake IHC staining images from H&E staining images. Due to the staining method and the difficulties in acquiring pathology images, it is hard to have 100% matched pairs of H&E staining images and IHC staining images for training. A weakly paired image translation GAN from H&E staining images to IHC staining images is proposed.

   - **Nuclei instance segmentation and classification in H&E images:** Nuclei type and distribution in H&E are essential for analyzing diseases. However, manually counting the nuclei and classifying the type of nuclei are impossible missions for pathologists. In this project, we propose novel deep-learning methods which can accurately segment and classify nuclei from H&E images.

- **Weakly supervised nuclei distribution prediction in H&E images:** Although nuclei instance segmentation and classification can provide the number and location of a specific nuclei type, labels for nuclei instance segmentation are hard to acquire because it requires pathologists to mark manually. In this project, we propose novel weakly supervised deep-learning methods to measure the nuclei distribution only under the supervision of nuclei occupation rate in the image.

Programming Skills:

- Programming: proficient in Python, MATLAB, C++, Java
- Deep learning tools: proficient in TensorFlow, PyTorch, Keras, Theano

Grants:

- CAHSI-Google Institutional Research Program Funding, $80,000 budget, with up to $20,000 Google Cloud Platform (GCP) credits.
- Students Partnering with Faculty (SpF) 2023 Awards, Kean University, $16,000 budget.

Peer Reviewed Journal Articles

1. M. Xu, **K. Huang**, X. Qi, Regional-Attentive Multi-Task Learning Framework for Breast Ultrasound Image Classification and Segmentation, accepted by IEEE Access (Impact Factor = 3.476), 2023.
2. **K. Huang**, Y. Zhang, H. D. Cheng, P. Xing, Trustworthy Breast Ultrasound Image Semantic Segmentation Based on Fuzzy Uncertainty Reduction, in Healthcare (Impact Factor = 3.160), 2022.
3. Y. Zhang, M. Xian, H. D. Cheng, B. Shareef, J. Ding, F. Xu, **K. Huang**, B. Zhang, C. Ning, Y. Wang, BUSIS: A Benchmark for Breast Ultrasound Image Segmentation, in Healthcare (Impact Factor = 3.160), 2022.
4. **K. Huang**, Y. Zhang, H. D. Cheng, P. Xing, B. Zhang, Semantic Segmentation of Breast Ultrasound Image with Fuzzy Deep Learning Network and Breast Anatomy Constraints, in Neurocomputing (Impact Factor = 5.719), 2021.
5. Q. Yu, **K. Huang**, Y. Zhu, X. Chen, W. Meng, Preliminary results of computer-aided diagnosis for magnetic resonance imaging of solid breast lesions, in Breast Cancer Research and Treatment (Impact Factor = 4.872), 2019.

Peer Reviewed Conference Papers

1. J. Huang, **K. Huang**, M. Xu and F. Liu, CFAB: An Online Data Augmentation to Alleviate the Spuriousness of Classification on Medical Ultrasound Images, accepted by the 14th International Conference on Computer Vision Systems (ICVS 2023).
2. E. Ponte, X. Amparo, **K. Huang**, and D. Kwak, Automatic Pill Identification System based on Deep Learning and Image Preprocessing, accepted by the 27th International Conference on Image Processing, Computer Vision, & Pattern Recognition (IPCV 2023).
3. **K. Huang**, J. Huang, W. Wang, M. Xu, F. Liu, A Deep Active Learning Framework with Information Guided Label Generation for Medical Image Segmentation, in IEEE International Conference on Bioinformatics and Biomedicine 2022 (IEEE BIBM 2022).
4. **K. Huang**, Y. Cheng, Q. Gao, B. Zhang, Weakly Unpaired Image Translation from Hematoxylin and Eosin Staining Image to Immunohistochemistry Staining Image, in IEEE International Conference on Bioinformatics and Biomedicine 2022 (IEEE BIBM 2022).
5. M. Xu, **K. Huang**, X. Qi, Multi-Task Learning with Contextual Oriented Self-Attention for Breast Ultrasound Image Classification and Segmentation, in IEEE International Symposium on Biomedical Imaging 2022 (ISBI 2022).
6. **K. Huang**, M. Xu, X. Qi, NGMMs: Neutrosophic Gaussian Mixture Models for Breast Ultrasound Image Classification, in the 43rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC 2021).

7. Y. Xiao, **K. Huang**, S. Niu, J. Huang, Interpretable Fine-grained BI-RADS Classification of Breast Tumors, in the 43rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC 2021).
8. **K. Huang**, Y. Zhang, H. D. Cheng, P. Xing, MSF-GAN: Multi-Scale Fuzzy Generative Adversarial Network for Breast Ultrasound Image Segmentation, in the 43rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC 2021).
9. **K. Huang**, Y. Zhang, H. D. Cheng, P. Xing, Shape-Adaptive Convolutional Operator for Breast Ultrasound Image Segmentation, in IEEE International Conference on Multimedia and Expo 2021 (ICME 2021).
10. M. Xu, **K. Huang**, Q. Chen, X. Qi, MSSA-Net: Multi-scale Self-attention Network for Breast Ultrasound Image Segmentation, in IEEE International Symposium on Biomedical Imaging 2021 (ISBI 2021).
11. **K. Huang**, Y. Zhang, H. D. Cheng, P. Xing, B. Zhang, Semantic Segmentation of Breast Ultrasound Image with Pyramid Fuzzy Uncertainty Reduction and Direction Connectedness Feature, in 2020 25th International Conference on Pattern Recognition (ICPR 2020).
12. **K. Huang**, H. D. Cheng, Y. Zhang, B. Zhang, P. Xing, C. Ning, Medical Knowledge Constrained Semantic Breast Ultrasound Image Segmentation, in 2018 24th International Conference on Pattern Recognition (ICPR 2018).
13. F. Xu, M. Xian, Y. Zhang, **K. Huang**, H. D. Cheng, B. Zhang, J. Ding, C. Ning, Y. Wang, A Hybrid Framework for Tumor Saliency Estimation, in 2018 24th International Conference on Pattern Recognition (ICPR 2018).

Services

- Served as a reviewer the following journals and conferences:
    1. Computational and Structural Biotechnology Journal
    2. Journal of Computer Science and Technology
    3. IEEE Winter Conference on Applications of Computer Vision
    4. IEEE International Conference on Pattern Recognition
    5. Sensors
    6. Electronics
    7. Algorithms
    8. Applied Science
    9. Intelligent Data Analysis
    10. Heliyon
    11. Current Medical Imaging
- Being an IEEE member
- Being an IEEE Engineering in Medicine and Biology Society Member
- Attended Undergraduate Open House, Kean University, 11/06/2022
- Attended Graduate Open House, Kean University, 10/16/2022
- Served as academic advisor of undergraduate students, Fall 2022, Kean University
- Helped other faculties facilitate research by setting up GPU server
- Helped other faculties set up Canvas
- Ph.D. student interviewer of tenure-track candidates during their on-site interviews at Utah State University, Spring 2020

Honors and Awards

Best Dissertation Award	USU, 2022
Travel grant of the 24th International Conference on Pattern Recognition	Beijing, 2018
Outstanding Individual Student Scholarship, School of Electrical Engineering	HIT, 2014
Excellent Students of Harbin Institute of Technology	HIT, 2014
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Third prize of Chinese Mathematics Competitions	Heilongjiang Province, 2013
Excellent Volunteer in Freescale Cup National College Students Intelligent	HIT, 2013
Second prize in Project Design for the freshman, School of Electrical Engineering	HIT 2013
Outstanding Individual Student Scholarship, School of Electrical Engineering	HIT 2013
Third prize in Adolescents Science and Technology Innovation Contest	China 2013

Professional Training

- Attended CURF Workshop: Student-Faculty Research Opportunities at Kean University in 2022
- Attended the New Faculty Orientation at Kean University in 2022
- Attended the workshop: Pathways to Independence: Preparing K99/R00, Understanding NIH in 2022
- Attended the Empowering Teaching Excellence program and received professional training with the Canvas platform and course design at Utah State University in 2022.
- Attended the Equity in Graduate Education panel at Utah State University in 2021.
- Attended the Graduate Student Proposal Writing Seminars at Utah State University in 2021.