Chunsu Park

https://chunsupnu.github.io/

Interests

Medical Image Analysis, Generalization, Multi-Modal Data, Explainable AI

Education

Pusan National University Mar. 2021 – Feb. 2023
Master of Science in Information Convergence Engineering Busan, Korea

- Graduation Thesis: "Deep learning networks and interpretation for bone marrow edema detection in dual-energy CT" (Major: Artificial Intelligence)
- GPA: 4.44/4.5 (4.0 scale: 4.0)

Jeonbuk National University Mar. 2010 – Feb. 2017
Bachelor of Science in Industrial and Information Systems Engineering Jeonju, Korea
Bachelor of Business Administration

- Graduated as the *Salutatorian* in the department (2/46)
- Military Service in Republic of Korea Army during 2011- 2013
- GPA: 4.05/4.5 (4.0 scale: 3.64)

Selected Publications (†:co-first, *:corresponding)

Chunsu Park, S. Kim, D.E. Lee, S.Y. Lee, A. Kambaluru, C. Park, M.W. Kim*, "CAPTURE-GAN: Conditional Attribute Preservation through Unveiling Realistic GAN for artifact removal in dual-energy CT imaging," *The 27th Medical Image Computing and Computer Assisted Intervention (MICCAI)*, 2024, Marrakesh, Morocco [Link] [Code]

D.E. Lee, **Chunsu Park**, S.Y. Lee, SiYeoul Lee, M.W. Kim*, "Convolutional Implicit Neural Representation of pathology whole-slide images," *The 27th Medical Image Computing and Computer Assisted Intervention (MICCAI)*, 2024, Marrakesh, Morocco. [Link] [Code]

Chunsu Park, J.W. Kang, D.E. Lee, W. Son, S.M. Lee, C. Park*, M.W. Kim*, "W-DRAG: A joint framework of WGAN with data random augmentation optimized for generative networks for bone marrow edema detection in dual energy CT," *Computerized Medical Imaging and Graphics (IF: 5.4, JCR 2023 <9%)*, 2024, 115, 102387. [Link] [Code]

J.W. Kang, **Chunsu Park**, D.E. Lee, J.H. Yoo, M.W. Kim*, "Prediction of bone mineral density in CT using deep learning with explainability," *Frontiers in Physiology (IF: 3.2, Q2)*, 2023, 13, 1061911. [Link]

Chunsu Park†, M.W. Kim†, C. Park*, W. Son, S.M. Lee, H.S. Jeong, J.W. Kang, M.H. Choi, "Diagnostic performance for detecting bone marrow edema of the hip on dual-energy CT: Deep learning model vs. musculoskeletal physicians and radiologists," *European Journal of Radiology (IF: 3.2, Q1)*, 2022, 152, 110337. [Link]

Conference Presentations (*:corresponding)

Chunsu Park, S. Kim, D.E. Lee, S.Y. Lee, A. Kambaluru, C. Park, M.W. Kim*, "A Conditional GAN Approach for Artifact Removal: Preserving Pathological Patterns in Dual-energy CT Imaging," *The 110th Radiological Society of North America (RSNA)*, 2024, Chicago, USA (Scientific Poster Session)

Chunsu Park, D.E. Lee, S. Kim, S.Y. Lee, M.W. Kim*, "Mask CycleGAN for removing artifacts in dual-energy CT," *The 8th IEEE International Conference on Consumer Electronics-Asia (ICCE-Asia)*, 2023, Busan, South Korea (Oral Session)

Chunsu Park, W. Son, H.S. Jeong, S.M. Lee, M.W. Kim, C. Park*, "Diagnostic performance for detecting bone marrow edema on dual-energy CT with Deep learning networks," *The 20th Asian Oceanian Congress of Radiology in conjunction with the 78th Annual Meeting of the Korean Society of Radiology (AOCR & KCR)*, 2022, Seoul, South Korea (Oral Session)

Chunsu Park, D.E. Lee, C. Park, M.W. Kim*, "Deep learning-based bone marrow edema detection using dual-energy CT with multi-channel data fusion," *International Biomedical Engineering Conference (IBEC)*, 2021, Virtual Conference (Oral Session)

Research Experience

AI-based Medical Imaging LAB (PI: Professor MinWoo Kim)

Full-Time Research Fellow Mar. 2023 – Present

- Designed and implemented a model utilizing 4D beamformed data to enhance vascular imaging by effectively separating clutter from blood signals.
- Contributed to image enhancement, neural representation, and network integration projects.
  - Developed an unsupervised framework for artifact removal in dual-energy CT.
  - Second author on a study on implicit neural representation in pathology.
  - Incorporated bone priors and pre-trained classification network to improve model robustness.
- Published research in peer-reviewed journals and presented findings at international conferences, including MICCAI 2024 and RSNA 2024.

Graduate Research Assistant Mar. 2021 – Feb. 2023

- Led project on detecting bone marrow edema in dual-energy CT, implemented multi-task learning approach to generate synthetic dual-energy CT images, won 1st place prize in graduate student-led research project and best paper award, and published paper based on work.
- Participated in projects on medical image classification, segmentation, and explainable AI.
  - Developed solutions to mitigate data scarcity in training classification networks.
  - Contributed to bone mineral density estimation and explainable method for regression network.
  - Introduced interpretable methods using principal component analysis.

Teaching Experience

PNU Graduate Students Mentoring Program May. 2022 – Dec. 2022

Group Mentor

- Led research activities, ultrasound equipment intro, graduate life orientation for new students.

Basic Computer Programming May. 2021 – Jul. 2022

Teaching Assistant

- Assisted in Python Programming and Data Structure.
- Led twice weekly labs for 40+ students, and weekly office hours. Proctored and marked exams.

Awards and Honors

Best Paper Award, The Korean Society of Medical & Biological Engineering, 2024
Academic Excellence Award (Amount: $755), Brain Korea 21, Pusan National University, 2023
Foundation Scholarship (Total amount: $9,500), Pusan National University, S21, F21, S22, F22
Graduate Student-led Research Project, 1st place, Pusan National University, 2022
PNU-Fellowship (Amount: $3,800), Brain Korea 21, Pusan National University, 2022
Medical Image AI Challenge (Pathology), 3rd place, Seoul National University Hospital, 2021
Best Paper Award, International Biomedical Engineering Conference (IBEC), 2021
Academic Scholarship (Total amount: $1,287), F10, F11, S15, F15, Jeonbuk National University
Work-Study Scholarship (Total amount: $3,114), S14, S15, F15, Jeonbuk National University
National Grant Scholarship (Total amount: $706), S15, F15, Jeonbuk National University

Work and Service

Product and System Manager in Insurance division 2018 – 2020

M Financial Service Inc.

- Customized product recommendation and information management.

International Volunteer Service in Vietnam Jun. – Jul. 2014

Hue University & Jeonbuk National University

- Advanced equal access to educational resources for students in marginalized groups.

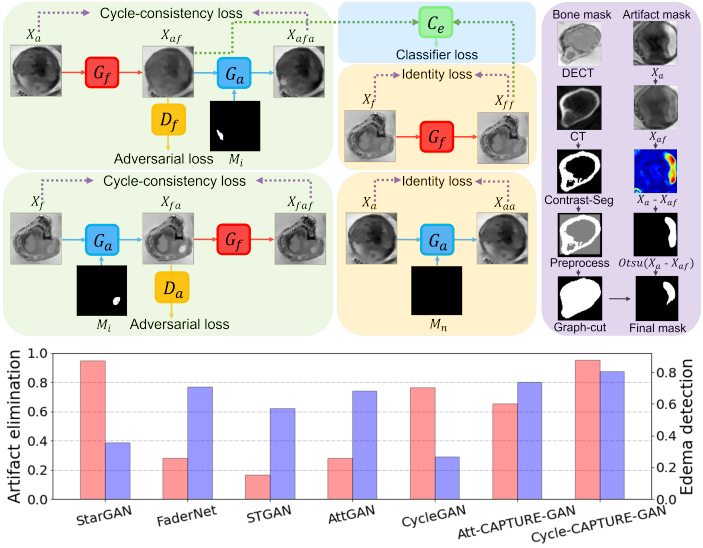
Military Service: Sergeant, Signal Corps 2011 – 2013

Republic of Korea Army, South Korea

- Led squadron of 15+ recruits involved in training exercises.

Technical Skills

Advanced Python, PyTorch, TensorFlow, LaTeX
Moderate C, MATLAB, MySQL

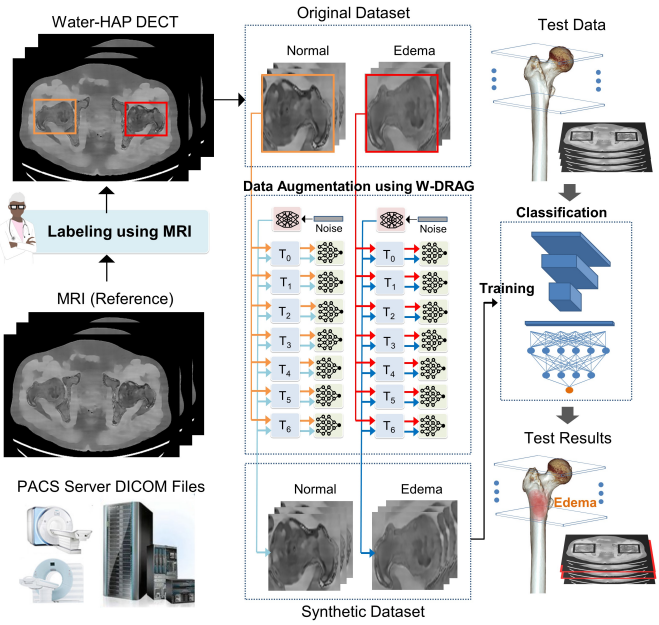


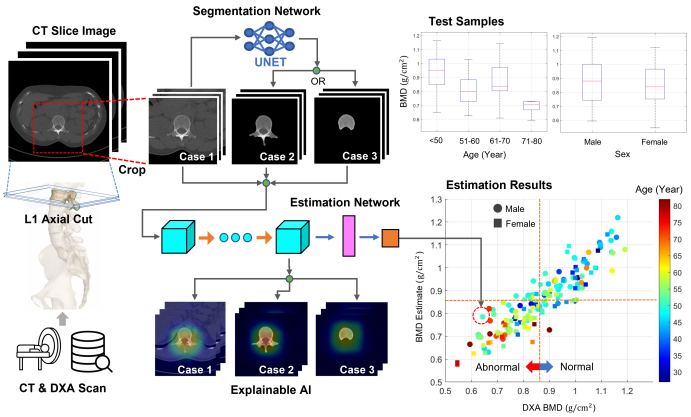
Removing artifacts while preserving pathological patterns in DECT

This study addresses the challenge of detecting bone marrow edema (BME) in dual-energy CT (DECT), which suffers from artifacts inherent in DECT imaging. Although AI-based solutions have advanced image enhancement, removing artifacts in DECT is difficult due to the challenge of not being able to obtain paired ground-truth images for supervised learning. To address this, we propose CAPTURE-GAN, an unsupervised generative model that integrates masking and classification models to reduce artifacts while preserving BME pathology and bone integrity. By incorporating bone priors and adding a disease classification network, CAPTURE-GAN preserved pathological patterns in over 80% of the data while effectively removing artifacts in 87.7% of the data.

Data augmentation with GAN (W-DRAG)

We developed a deep learning framework to screen diseases from axial bone images and pinpoint bone lesion locations. To address the lack of labeled data, we used a generative adversarial network (GAN) beyond conventional augmentation methods to generate synthetic images. We optimized data augmentation for GAN to ensure stable image generation and trained a classification model using both real and synthetic samples. The W-DRAGS method generated more realistic and diverse DECT images. Augmenting the classification network's training data with these images resulted in an accuracy of 87.7%, an F1-score of 80%, a sensitivity of 81.5%, and a specificity of 90.4%. Additionally, we introduced an explainable AI technique using principal component analysis to visually analyze the network's outputs. Its explainable approach aids decision-making by visualizing the network's prediction process and offering insights into the model's limitations, thereby guiding future improvements.





Bone mineral density prediction networks in CT with explainability

Bone mineral density (BMD) is vital for diagnosing bone diseases, yet CT imaging lacks BMD data, requiring DXA and additional radiation. This study developed a deep learning model to estimate BMD from axial CT scans of the L1 vertebra. We used three distinct datasets to train and evaluate the model, achieving an F1 Score of 0.875 and an accuracy of 86.4% in Case 2. Additionally, two explainable AI methods, gradient-weighted regression activation map (Grad-RAM) and Grad-RAM by pixel (Grad-RAMP), were developed based on the Grad-CAM approach. These methods identify the specific anatomical regions influencing the model's BMD predictions, providing transparency that is crucial for clinical adoption. This approach can assist clinical practice and automatically screen CT databases for latent patients.

References

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