Guest Editorial
Artificial Intelligence in Pre-DICOM

ARTIFICIAL intelligence (AI) for medical imaging is applied in three domains: pre-DICOM, pre-processing and clinical applications. Clinical applications mainly cover topics such as disease detection, classification, segmentation, registration. Pre-processing components are mainly designed for facilitating applications using image transformation such as image normalization, noise reduction, bias correction in MR. AI in the pre-DICOM domain is expected to improve imaging workflow, image protocol selection, imaging quality, imaging scanning time before images are converted into DICOM format for radiologists to review. The trends of AI publications in medical imaging have been gradually extended from clinical applications to pre-processing and, to pre-DICOM. The papers in this special section seek to present and highlight the latest development on applying advanced deep learning techniques in pre-DICOM space.

This special issue of the IEEE Journal of Biomedical and Health Informatics journal seeks to present and highlight the latest development on applying advanced deep learning techniques in pre-DICOM space. It has attracted a fair number of submissions from researchers active in the area of deep learning with application before DICOM images are generated. In total 21 manuscripts were submitted. After careful peer review, 5 manuscripts have finally been selected for publication in this special issue, covering the topics including image quality, reconstruction, imaging protocol automation and synthetic image generation. The techniques are applied on various modalities such as X-ray, MRI and ultrasound.

Important works presented in this special issue address challenges in the field of imaging protocol automation. Sun et al. [A1] leveraged the deep learning-based automatic recognition of the scanning or exposing region in medical imaging automation, which can decrease the heavy workload of the radiographers, optimize imaging workflow and improve image quality. They proposed an automatic video analysis framework based on the hybrid model, approaching real-time performance. The framework consists of three interdependent components: Body Structure Detection, Motion State Tracing, and Body Modelling. Body Structure Detection disassembles the patient to obtain the corresponding body key points and body Bboxes. A large-scale dataset for X-ray examination scene is built to validate the performance of the proposed method. Extensive experiments demonstrate the superiority of the proposed method in automatically recognizing the exposure moment and exposure region.

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In the area of image reconstruction, Wei et al. [A2] present a method for to speed up scan time of MRI. A cross-domain two-stage generative adversarial network is proposed for multi-contrast images reconstruction based on prior full-sampled contrast and undersampled information. The new approach integrates reconstruction and synthesis, which estimates and completes the missing k-space and then refines in image space. It takes one fully-sampled contrast modality data and highly undersampled data from several other modalities as input, and outputs high quality images for each contrast simultaneously. The network is trained and tested on a public brain dataset from healthy subjects. Quantitative comparisons against baseline clearly indicate that the proposed method can effectively reconstruct undersampled images. Even under high acceleration, the network still can recover texture details and reduce artifacts.

In Magnetic Resonance Imaging (MRI), cardiac triggering that synchronizes data acquisition with cardiac contractions is an essential technique for acquiring high-quality images. Triggering is typically based on the Electrocardiogram (ECG) signal (e.g., R-peak). Since ECG acquisition involves extra workflow steps like electrode placement and ECG signals are usually disturbed by magnetic fields in high Magnetic Resonance (MR) systems, Wang et al. [A3] explored camera-based photoplethysmography (PPG) as an alternative. They found that that camera-PPG provides a higher availability of signal (and trigger) measurement, and the PPG signals measured from the forehead show considerably less delay w.r.t. the coupled ECG R-peak than the finger PPG signals in terms of trigger detection. The insights obtained in this study provide a basis for an envisioned system design phase.

In ultrasound imaging, Liu et al. [A4] proposed a blind deep super resolution (SR) method based on progressive residual learning and memory upgrade. They constructed three modules - up-sampling (US) module, residual learning (RL) model and memory upgrading (MU) model for ultrasound image blind SR. The US module is designed to upscale the input information and the up-sampled residual result is used for SR reconstruction. The RL module is employed to approximate the original LR and continuously generate the updated residual and feed it to the next US module. The last MU module can store all progressively learned residuals, which offers increased interactions betsen the US and RL modules, augmenting the details recovery. Extensive experiments and evaluations on the benchmark CCA-US and US-CASE datasets were performed.

In the area of Retinal Optical Coherence Tomography Angiography (OCT-A), Hao et al. [A5] presented a novel sparse-base domain adaptation super-resolution network (SASR) for the reconstruction of realistic OCT-A images by reducing the difference between the spatial feature domain of the synthetic and the realistic images. To achieve this, they proposed a multi-level super-resolution model for the fully supervised reconstruction through a generative-adversarial strategy. Additionally, authors designed a novel sparse edge-aware loss to dynamically optimize the vessel edge structure. Authors evaluated the performance of the proposed method through image resolution improvement tasks and segmentation tasks using SURE-O and SURE-Z datasets for retina structure regions. Their experiment results of their proposed method demonstrate superior performance on both synthetic and realistic images. Extensive experiments and evaluations were performed.

All 5 papers tackle different but extremely relevant domain issues of Pre-DICOM field. We believe this Special Issue will raise awareness in the scientific and industry community that a multidisciplinary research path is therefore in need to meet the desire from healthcare providers that are emerging in this field.

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Appendix
Related Articles

[A1] J. Sun et al., “Automatic video analysis framework for exposure region recognition in x-ray imaging automation,” *IEEE J. Biomed. Health Inform.*, vol. 26, no. 9, pp. 4359–4370, Sep. 2022.

[A2] H. Wei, Z. Li, S. Wang, and R. Li, “Undersampled multi-contrast MRI reconstruction based on double-domain generative adversarial network,” *IEEE J. Biomed. Health Inform.*, vol. 26, no. 9, pp. 4371–4377, Sep. 2022.

[A3] W. Wang et al., “Fundamentals of camera-PPG based magnetic resonance imaging,” *IEEE J. Biomed. Health Inform.*, vol. 26, no. 9, pp. 4378–4389, Sep. 2022.

[A4] H. Liu, J. Liu, F. Chen, and C. Shan, “Progressive residual learning with memory upgrade for ultrasound image blind super-resolution,” *IEEE J. Biomed. Health Inform.*, vol. 26, no. 9, pp. 4390–4401, Sep. 2022.

[A5] H. Hao et al., “Sparse-based domain adaptation network for OCTA image super-resolution reconstruction,” *IEEE J. Biomed. Health Inform.*, vol. 26, no. 9, pp. 4402–4413, Sep. 2022.