Deep Learning-Based Classification of 3D CT Scans with Real Clinical Data; Impact of Image format

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Abstract : Background: Artificial intelligence (AI) serves as a valuable tool in mitigating the scarcity of human resources required for the evaluation and categorization of vast quantities of medical imaging data. When AI operates with optimal precision, it minimizes the demand for human interpretations and, thereby, reduces the burden on radiologists. Among various AI approaches, deep learning (DL) stands out as it obviates the need for feature extraction, a process that can impede classification, especially with intricate datasets. The advent of DL models has ushered in a new era in medical imaging, particularly in the context of COVID-19 detection. Traditional 2D imaging techniques exhibit limitations when applied to volumetric data, such as Computed Tomography (CT) scans. Medical images predominantly exist in one of two formats: neuroimaging informatics technology initiative (NIfTI) and digital imaging and communications in medicine (DICOM). Purpose: This study aims to employ DL for the classification of COVID-19-infected pulmonary patients and normal cases based on 3D CT scans while investigating the impact of image format. Material and Methods: The dataset used for model training and testing consisted of 1245 patients from IranMehr Hospital. All scans shared a matrix size of 512 × 512, although they exhibited varying slice numbers. Consequently, after loading the DICOM CT scans, image resampling and interpolation were performed to standardize the slice count. All images underwent cropping and resampling, resulting in uniform dimensions of 128 × 128 × 60. Resolution uniformity was achieved through resampling to 1 mm × 1 mm × 1 mm, and image intensities were confined to the range of (−1000, 400) Hounsfield units (HU). For classification purposes, positive pulmonary COVID-19 involvement was designated as 1, while normal images were assigned a value of 0. Subsequently, a U-net-based lung segmentation module was applied to obtain 3D segmented lung regions. The pre-processing stage included normalization, zero-centering, and shuffling. Four distinct 3D CNN models (ResNet152, ResNet50, DensNet169, and DensNet201) were employed in this study. Results: The findings revealed that the segmentation technique yielded superior results for DICOM images, which could be attributed to the potential loss of information during the conversion of original DICOM images to NIFTI format. Notably, ResNet152 and ResNet50 exhibited the highest accuracy at 90.0%, and the same models achieved the best F1 score at 87%. ResNet152 also secured the highest Area under the Curve (AUC) at 0.932. Regarding sensitivity and specificity, DensNet201 achieved the highest values at 93% and 96%, respectively. Conclusion: This study underscores the capacity of deep learning to classify COVID-19 pulmonary involvement using real 3D hospital data. The results underscore the significance of employing DICOM format 3D CT images alongside appropriate pre-processing techniques when training DL models for COVID-19 detection. This approach enhances the accuracy and reliability of diagnostic systems for COVID-19 detection.

Keywords : deep learning, COVID-19 detection, NIFTI format, DICOM format
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