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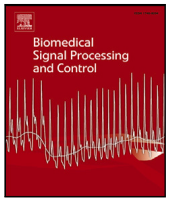

ADU-Net: An Attention Dense U-Net based deep supervised DNN for automated lesion segmentation of COVID-19 from chest CT images

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ABSTRACT

An automatic method for qualitative and quantitative evaluation of chest Computed Tomography (CT) images is essential for diagnosing COVID-19 patients. We aim to develop an automated COVID-19 prediction framework using deep learning.

We put forth a novel Deep Neural Network (DNN) composed of an attention-based dense U-Net with deep supervision for COVID-19 lung lesion segmentation from chest CT images. We incorporate dense U-Net where convolution kernel size 5×5 is used instead of 3×3. The dense and transition blocks are introduced to implement a densely connected network on each encoder level. Also, the attention mechanism is applied between the encoder, skip connection, and decoder. These are used to keep both the high and low-level features efficiently. The deep supervision mechanism creates secondary segmentation maps from the features. Deep supervision combines secondary supervision maps from various resolution levels and produces a better final segmentation map. The trained artificial DNN model takes the test data at its input and generates a prediction output for COVID-19 lesion segmentation. The proposed model has been applied to the MedSeg COVID-19 chest CT segmentation dataset. Data pre-processing methods help the training process and improve performance.

We compare the performance of the proposed DNN model with state-of-the-art models by computing the well-known metrics: dice coefficient, Jaccard coefficient, accuracy, specificity, sensitivity, and precision. As a result, the proposed model outperforms the state-of-the-art models.

This new model may be considered an efficient automated screening system for COVID-19 diagnosis and can potentially improve patient health care and management system.

1. Introduction

The worldwide pandemic caused by COVID-19 has badly affected human life and healthcare services. The SARS-CoV-2 virus variants[1] are genetically changing over time, circulating globally [1], and causing COVID-19 disease. The World Health Organization[2] reports that COVID-19 confirmed cases are more than 526 million and COVID-19 death cases are more than 6.2 million all over the world as of 30th May 2022. The COVID-19 disease may cause cytokine storms involving multiple organ failures, including lungs, leading to COVID-19 pneumonia that ultimately leads to pulmonary fibrosis in all age groups [2]. Therefore, early diagnosis of pulmonary is very crucial. Chest CT [3–5] is an important tool in diagnosing clinically suspicious COVID-19 pneumonia early. The hospitals and health centres of developing and underdeveloped countries are equipped with High-Resolution CT (HRCT) and Magnetic Resonance Imaging (MRI) at a higher cost. The MRI applies magnetic waves instead of ionizing radiation like a CT or X-ray. However, a chest CT scan is more beneficial in detecting and quantifying COVID-19 than MRI. We are inspired to develop an automated screening system using deep learning that can classify COVID-19 cases and identify the level of lung infections from conventional chest CT images. Though X-ray images are more inexpensive than CT images, they produce a high error rate, so CT images are useful for more accurate diagnosis [6]. Several slices of CT images are produced for each patient at the time of scans. These create a high workload on clinicians to detect COVID-19 manually [7]. Deep neural network models have recently brought a groundbreaking revolution in developing automated computer-assisted diagnosis (CAD)

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