Abstract

Omneya Amr Attallah

MULTI-DEEP: A novel CAD system for coronavirus (COVID-19) diagnosis from CT images using multiple convolution neural networks

Coronavirus (COVID-19) was first observed in Wuhan, China, and quickly propagated worldwide. It is considered the supreme crisis of the present era and one of the most crucial hazards threatening worldwide health. Therefore, the early detection of COVID-19 is essential. The common way to detect COVID-19 is the reverse transcription-polymerase chain reaction (RT-PCR) test, although it has several drawbacks. Computed tomography (CT) scans can enable the early detection of suspected patients, however, the overlap between patterns of COVID-19 and other types of pneumonia makes it difficult for radiologists to diagnose COVID-19 accurately. On the other hand, deep learning (DL) techniques and especially the convolutional neural network (CNN) can classify COVID-19 and non-COVID-19 cases. In addition, DL techniques that use CT images can deliver an accurate diagnosis faster than the RT-PCR test, which consequently saves time for disease control and provides an efficient computer-aided diagnosis (CAD) system. The shortage of publicly available datasets of CT images, makes the CAD system’s design a challenging task. The CAD systems in the literature are based on either individual CNN two-fused CNNs one used for segmentation and the other for classification and diagnosis. In this article, a novel CAD system is proposed for diagnosing COVID-19 based on the fusion of multiple CNNs. First, an end-to-end classification is performed. Afterward, the deep features are extracted from each network individually and classified using a support vector machine (SVM) classifier. Next, principal component analysis is applied to each deep feature set, extracted from each network. Such feature sets are then used to train an SVM classifier individually. Afterward, a Selected number of principal components from each deep feature set are fused and compared with the fusion of the deep features extracted from each CNN. The results show that the proposed system is effective and capable of detecting COVID-19 and distinguishing it from non-COVID-19 cases with an accuracy of 94.7%, AUC of 0.98 (98%), sensitivity 95.6%, and specificity of 93.7%. Moreover, the results show that the system is efficient, as fusing a Selected number of principal components has reduced the computational cost of the final model by almost 32%.