COVID-19 Classification through Deep Learning Models with Three-Channel Grayscale CT Images

ABSTRACT

COVID-19, an infectious coronavirus disease, has triggered a pandemic that has claimed many lives. Clinical institutes have long considered computed tomography (CT) as an excellent and complementary screening method to reverse transcriptase-polymerase chain reaction (RT-PCR). Because of the limited dataset available on COVID-19, transfer learning-based models have become the go-to solutions for automatic COVID-19 detection. However, CT images are typically provided in grayscale, thus posing a challenge for automatic detection using pre-trained models, which were previously trained on RGB images. Several methods have been proposed in the literature for converting grayscale images to RGB (three-channel) images for use with pre-trained deep-learning models, such as pseudo-colorization, replication, and colorization. The most common method is replication, where the one-channel grayscale image is repeated in the three-channel image. While this technique is simple, it does not provide new information and can lead to poor performance due to redundant image features fed into the DL model. This study proposes a novel image pre-processing method for grayscale medical images that utilize Histogram Equalization (HE) and Contrast Limited Adaptive Histogram Equalization (CLAHE) to create a three-channel image representation that provides different information on each channel. The effectiveness of this method is evaluated using six other pre-trained models, including InceptionV3, MobileNet, ResNet50, VGG16, ViT-B16, and ViTB32. The results show that the proposed image representation significantly improves the classification performance of the models, with the InceptionV3 model achieving an accuracy of 99.60% and a recall (also referred as sensitivity) of 99.59%. The proposed method addresses the limitation of using grayscale medical images for COVID-19 detection and can potentially improve the early detection and control of the disease. Additionally, the proposed method can be applied to other medical imaging tasks with a grayscale image input, thus making it a generalizable solution.