A Learning Based Noise Removal Method for COVID-19 Detection Using Chest X-Ray Image

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Abstract
An infectious disease known as covid-19 spread throughout the globe in the year 2019. Covid-19 initially originated from a research lab located in Wuhan, China. Covid-19 has affected around more than 79 countries across the globe. Covid-19 had majorly affected the Indian economy in terms of financial and human resource loss. More than half millions of people in India died due to Covid-19. Initially the detection of covid-19 is one of the major concerns as the testing kits and slots are limited. Also, the expected time for a covid-19 patient to receive report was more than 36 hours. To address this major challenge radiologists, start to detect the covid-19 from the patient chest X-ray image. In this paper a novel method had been proposed to enhance the chest X-ray images for better detection of the Covid-19. Theproposed method had shown the better PSNR value in contrast with existing methods.
Keywords: X-RAY, COVID-19, PSNR, CAD, CLAH

1. Introduction

Image enhancement is one of the most important steps before preparing any computer aided diagnostic model (CAD). Most of the original images were degraded due to the induction of noise, which degrade the images pixel and sometime blur the image.

A CheXNet frame work had been proposed in [1] which is used to detect COVID-19 sing X-ray images of the chest. In this work the ResNet architecture had been used along with efficient noise removal method. Author had proposed CLAHE method with a butter width band filter to normalize the noisy images. The complexity of the training is quite low and acceptable. The proposed model had shown the PSNR value of more than 40 that help in image enhancement.

In [2], author had proposed an image enhancement method for faster COVID-19 detection. Author had discussed many existing methods like HE, CLAHE and invert segmentation. The pre-processing of the images is done using the N-CLAHE where the clip limit and high pixel value replacement changes in every round. Then the pixels re-distribution is done in the way to preserve all the edges. The proposed model had shown the validation accuracy of more than 94% for the accurate COVID-19 detection.

1.1 Histogram Equalization (HE) Method

This method aims to equally distribute the image grey levels in all the region of the image. All the grey level has their chance of occurrence. The histogram equalization will help to improve the dark and lower contrast regions of the image for enhancement. The goal is to create a balance histogram for enhanced image [3]. In order to create a balanced histogram, the grey levels can also be distributed in the darker region to increase the image clarity for enhancement. The histogram of such images

can be represented using a discrete functiongiven below:

$h(r_k) = n_k$

where r_k is the intensity value of kth pixel andn_k is the total number of pixels in the image.

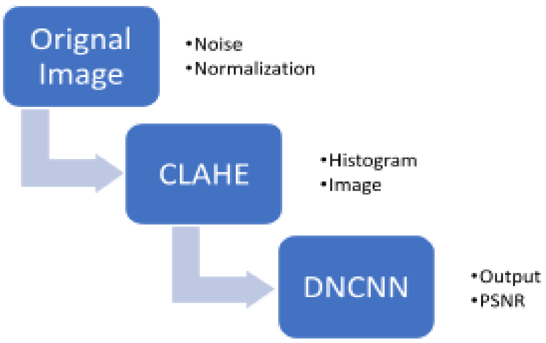

Figure 1: Proposed Method for Image Enhancement

2. Algorithm and Method

a. Contrast Limited Adaptive HistogramEqualization (CLAHE) Method

CLAHE is an improve variant of histogramequalization. It helps in improving the image local features and preserve the image edges adaptively. Using CLAHE local feature of an image can be enhanced in the darker areas too. Initially the image is divided into several non-overlapping regions where all sub images are of almost equal size. Then the histogram forall the regions will be computed to check the clip limit. Then according to the clip limit the redistribution is done.

In this work the adaptive CLAHE is proposed that will clip the window dynamically. The clip size will change in every round.

Algorithm for adaptive CLAHE

Input: Dataset 379 Images Chest-XrayOutput: Enhanced Image, PSNR

Steps:

1. For c = 0 to c = 8, generate sub-image =8 x 8 = 64 images.
2. Initialize [c] = 0;
3. Set c = [c] loop

4. Generate 8 x 8, sub images
5. For c in 1..8 loop
6. Compute HPV i.e., highest pixel value &NPV i.e. normal pixel value
7. If NPV < HPV distribute HPV andre-normalize the image
8. Map areas with dark pixel do
9. Output Image

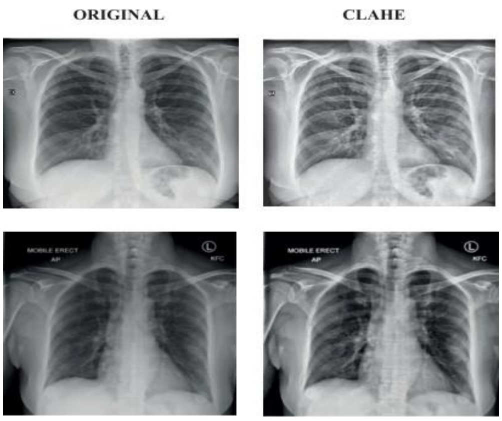

Figure 2: CLAHE Enhancement

b. Deep Learning Architecture

The DnCNN has total 3 different layers as shown in figure 2. The first layer is conv + ReLU layer containing 64 filters with 3 x 3 x c feature map for the image. The c is color channel of the image that has value 1 for grey image and 3 for colored images. The second layer combines conv + BN + ReLU layer used for batch normalization containing 3 x 3 x 64 size blocks. The last layer is used for the image re-construction containing 3 x 3 x 64 sized block. For noise removal DnCNN use the method of residual learning and to speed up the de-noising process it uses batch normalization [1], [4], [5]. The architecture of DnCNN is as shown in figure 3 below:

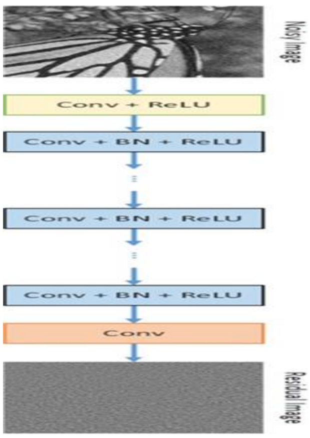

Figure 3: DnCNN Architecture

3. Experimental Setup

The process of image enhancement is done using MATLAB-2021 edition [4], [6]. The images areacquired from benchmark dataset given of Kaggle. The link to dataset is given as below:

Dataset: https://www.kaggle.com/tawsifurrahman/covid19-radiography-database

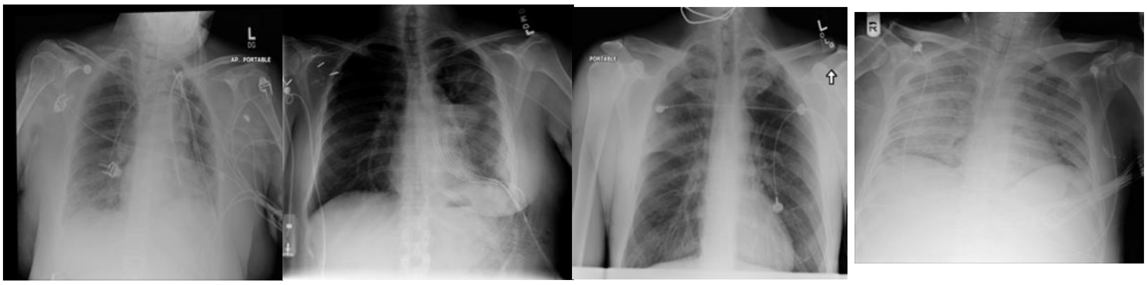

Figure 4: Enhanced Images after Pre-Processing

Figures 4 had shown the normal and enhancedimages chest X-ray images. The adaptive CLAHE had enhanced the image quality by removing the unwanted noise and adding the HPV.

Author	HE	AHE	CLAHE
[7]	8.65	15.78	29.08
[8]	10.34	15.90	30.02
[9]	11.23	16.76	31.89
[10]	10.65	18.87	32.87
Proposed	12.08	20.23	34.95

Table I: Comparison of PSNR for existing andproposed method

Author	MSE	PSNR
[9]	0.56	46
[8]	0.65	48
[7]	0.63	53
[11]	0.34	43
[12]	0.59	44
[13]	0.23	51
Proposed	0.13	60.5

4. Conclusion

The image pre-processing is one of the most important steps on the way to develop a CAD system.The original image is exposed to various noises that degrade their quality and edges. It makes difficult for a radiologist to detect the patient status correctly. In this paper initially the CLAHE method had been used along with DnCNN that helps in enhancing the images quality. The proposed work had shown a better PSNR value than various existing methods. In future the images can be segmented further for classification and detection.

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