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A COMPARISON OF IMAGE RESTORATION TECHNIQUES OF LUNG CT COVID-19 IMAGES

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Abstract:

The infectious SARS-CoV-2 is liable for the risky pneumonia-type diseases. Coronavirus has without a doubt changed the world by killing billions of individuals as of June 2021. Compromising the wellbeing of millions across the globe, the Computed Tomography (CT) imaging uncovers that the characteristics of these images for COVID-19 contaminated patients fluctuate from sound patients with or without other respiratory infections, like pneumonia. Early diagnosis is the best way to control the spread of Covid. In this complicated situation, lung computerized tomography (CT) images can be viably utilized for early distinguishing proof of Covid-19 patients These CT images are handled utilizing Computer Aided Diagnosis (CAD) procedures by the use of appropriate calculations. To work on the exactness of this finding, proper restoration techniques are fundamental. Image restoration techniques are used to get the best ideal results of the original image using instrumental conditions and noise level in the obtained image. In this paper, an original algorithm is proposed for CT image restoration called 2D Improved Anisotropic Diffusion Bilateral Filter (2D IADBF) for the viable noise reduction from the CT lung images. The proposed algorithm is compared with a few algorithms like 2D Median Filter, 2D Log Filter and 2D Frequency Domain Wavelet Filter and compared using parameter measurements like peak signal noise ratio (PSNR) in dB, mean square error (MSE) and processing time. Execution investigations show that the proposed algorithm delivers the best outcomes compared to the other algorithms. Consequently, these algorithms can be successfully utilized in the clinical pathway for the early finding of Covid-19.

Keywords: Covid-19, Restoration, CAD, CT image, Filter.

Introduction:

Computed tomography (CT) images are prominently being utilized in the field of computer vision, medicine to help the clinical specialists to analyze different illnesses. The CT images of the lungs can be utilized for the analysis of various infections. This is because of the development of abnormal infectious cells. These cells spread at a quick rate and influences the general working of the lungs. Further, early diagnosis proof is the main answer for saving the existence of individuals impacted by covid-19.

This is on the grounds that, the abnormal cells don't permit the individual to inhale at a normal rate. This causes respiratory issues which influences the breathing individuals. In this manner, early diagnosis of Covid-19 in the lungs utilizing the lung CT images is a recent survey in the last years[3].Compared to the handling of CT images , different images having high handling cost and handling time. A processed tomography sweep, or CT check, produces definite pictures of organs, bones, delicate tissues and veins. CT images permit doctors to recognize inward nodules and see their shape, size, thickness and surface. Not the same as regular X-Rays, CT filters produce a bunch of cuts of a given area of the body without overlaying the diverse body structures.

Huge numbers of cases were accounted for with breathing problems because of assault of Covid-19 in Wuhan, China in December 2019. This infection has an exceptionally quick spreading rate, and accordingly the entire world is assaulted by this infection. Prior identification of Covid-19 aides in the convenient arrangement of clinical consideration to the patients. This identification is possible with the assistance of lung CT pictures. There are two fundamental ways for the identification of Covid-19[6]. The primary method is the lab based methodology. This methodology includes the examination of tests of human like bodily fluid, throat swabs, RCPTR and blood. These examples are exposed to testing that elaborate nucleic corrosive testing, antigen testing, point testing, serology testing, etc[7]. In these tests, the swab materials are applied over paper strips that have fake antibodies. The normal affectability of this strategy is around 60-71%. The subsequent classification is the utilization of clinical imaging procedures like CT filter, x-ray, and so on .The materials acquired utilizing these imaging methods are then exposed to different algorithms[8].

These algorithms process the imaging information and give successful outcomes. The primary advances included incorporate pre-processing, segmentation and classification. The classification is done utilizing AI methods.. The pre-processing includes steps like restoration and enhancement [9]. Restoration is the initial step utilized for the removal of noise that is present in the image during the image acquisition step. Chest sweeps, for example, X-ray and Computer tomography (CT) examines have been utilized to distinguish morphological examples of lung injuries connected to the COVID-19. Nonetheless, the exactness of the finding of COVID-19 by Chest checks emphatically relies upon specialists have been examined as an instrument to mechanize and assist with the determination.

Literature Survey:

Wang et al. [11] introduced a plan for the determination of Covid-19 utilizing chest CT pictures. Information was gathered from the patients of Xiaogan, China. This work included distinguishing proof of the connection between the seriousness of the disease and the lymphocyte proportion. Further, the oxygen immersion level of the patients was additionally examined. Information from 110 patients were utilized for the examination.

Long et al. [12] proposed an exploration work for the location of Coronavirus sickness dependent on CT pictures and constant opposite transcriptase-polymerase chain response (rRT-PCR) information. Correlation of the indicative worth of the two techniques was acted in this exploration. Around 36 patients were utilized for the assortment of information. The affectability achieved by CT was found to 97.2% and that of rRT-PCR was 83.3%.

Hani et al. [13] introduced an audit on CT discoveries for the Covid-19 cases. This paper included investigation of different microbiological tests engaged with the recognizable proof of Covid-19. These tests included continuous opposite transcriptase-polymerase chain response and sequencing tests. The really differential determination results were assessed and introduced.

He et al. [14] introduced the demonstrative exhibition correlation of CT and rRT-PCR tests. This examination was directed utilizing patients outside Wuhan, china. 34 patients with Covid-19 and around 48 patients without Covid-19 were utilized for this review. It was seen as that there was no factual distinction among CT and ongoing opposite transcriptase-polymerase chain response tests.

Ozturk et al. [15] utilized profound neural organizations for the programmed location of Covid-19. X-beam pictures were utilized for the distinguishing proof of Covid. Crude chest X-beam pictures were procured and utilized in this examination. This framework included 17 convolutional layers. Grouping precision achieved by this plan was around 98.08%.

The literature overview undoubtedly shows that chest CT is extremely successful in the acknowledgment of Covid-19. Further, it was seen that the affectability achieved utilizing chest CT is higher than that of constant opposite transcriptase-polymerase chain response. Accordingly, chest CT information is utilized for the discovery of cellular damage in the lungs and Covid-19 in this exploration.

Existing System and Proposed System

The existing methods for image restoration utilize either anisotropic or bilateral filters separately. Thus preservation of gradient information and removal of speckle noise is not possible. The initial step is the image restoration. At first, the lung CT image information that addresses either cellular damage in the lungs of Covid-19 patient is gained. Then, at that point, the image filtration is finished utilizing the proposed 2D Improved Anisotropic Diffusion Bilateral Filter (2D IADBF). Then the restored noise free lung CT image is acquired that can be utilized for viable infection determination. The fundamental benefit of the proposed system is the significant level decrease of noise with concurrent confinement of edge data of the lung CT images. Further, the contrast and the brightness of the image are worked on in the resultant images.

Figure 1: Basic Architecture Diagram of Image Restoration of Covid-19

Image Restoration:

Image restoration is done to filter the noise from the lung CT images. This is done dependent on the blend of anisotropic bilateral model and the two-sided channel. Consider the info CT image to which the below algorithm is applied:

Algorithm 1: 2D Improved Anisotropic Diffusion Bilateral Filter (2D IADBF)

Input:

Input noisy CT lung image $I^{CT} \in R^{p\times q}$.

Steps:

- For the given input image define the anisotropic diffusion model using Equation $I^{CT}{}_{t}+1(u,v)=I_t(u,v)+\frac{1}{4}\sum_{i=1}^{4}[DC^i(u,v).\Delta I_t{}^i(u,v)]$.
- The diffusion coefficient is generated based on the gradient function using $DC^i(u,v)=gd(\Delta I)$.
- The gradient function is modified using bilateral function as $gd(\Delta I)=\frac{1}{1+(|\Delta I|/BF)^2}$.
- The bilateral function is defined using the gradient function to enable accurate noise filtration using Equation $BF=\frac{1}{NF}\sum_{i\in w}G_{sn}(\|u-v\|)G_{sn}(\|I_u-I_v\|)I_v$.
- Finally, the filtered image $F^{CT}\in R^{p\times q}$ is obtained using,

$$F^{CT}{}_{t+1}(u,v)=F^{CT}{}_{t}(u,v)+\frac{1}{4}[DC^i(u,v).\sigma^2(u,v)]$$

Output:

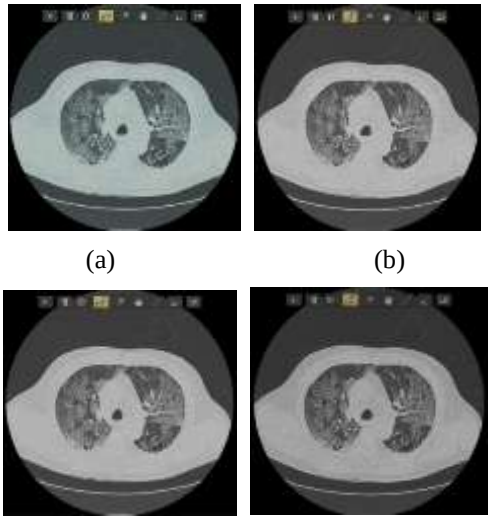
Filtered image $F^{CT}\in R^{p\times q}$.

Results and Discussion

All the experiments performed in this research were accomplished using MATLAB R2013b using a Laptop with Intel core i5 processor @4 GHz having8GB RAM. The proposed framework is implemented and results and discussion are given in the below section as qualitative analysis. The Covid lung CT images were obtained from the publicly available Imaging Archive dataset (https://onlinelibrary.wiley.com/doi/10.1002/emp2.12073). The size of the sub-block $n \times n$ was chosen as 8×8.

Qualitative analysis on Covid-19 images

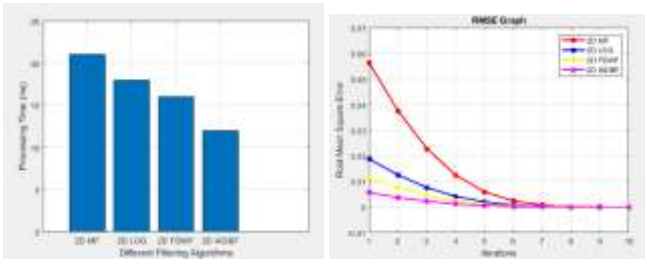
Figure 2 shows the Covid-19 CT lung input image restored using 2D Median filtering (MF), 2D Adaptive Log Gabor channel (LOG), 2D Frequency domain wavelet filter (FDWF) and the proposed 2D IADBF filter. It is obvious from Figure 2 that, the image is obscured on account of 2D median filter. Additionally, the noisy parts are as yet pervasive in the 2D Adaptive Log Gabor channel. The differentiation of the image filtered using 2D Frequency domain wavelet filter is likewise poor. Be that as it may, the proposed 2D IADBF filter creates best filtration results.



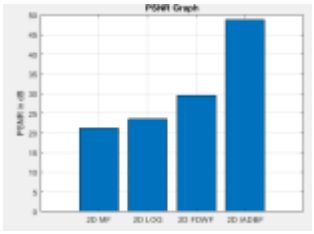
(a) (b)

(c) (d)

Figure 2.Coronavirus CT lung input image filtered utilizing (a) 2D Median filter (b) 2D Adaptive Log Gabor filter (c) 2D Frequency domain wavelet filter (d) Proposed 2D IADBF



(a) (b)



(c)

Figure 3: Comparison graphs of COVID CT Images (a) Processing Time Graph (b) RMSE Graph (c) PSNR Graph

Figure 3 shows the comparison of processing time, RMSE and PSNR for different filtering algorithms using Covid-19 CT lung image. It can be observed that the processing time for the 2D median filter (MF) is 22ms, 2D Adaptive Log Gabor filter (LOG) is 17.5ms, 2D Frequency domain wavelet filter (FDWF) is 16ms and the proposed 2D IADBF filter is only 13ms. Thus, the time taken for processing the proposed 2D IADBF algorithm is very low. Hence, it can be easily implemented at real-time. Table 1 shows the comparison of PSNR and MSE for different filtering algorithms using Covid-19 CT lung image. These values are computing using averaging technique with multiple images in the dataset. It is inferred that the average PSNR for the proposed algorithm is 42.72dB. Similarly, the average MSE for the proposed algorithm is 0.475. Thus, the error is minimal and is also less than 1. This shows the efficacy of the proposed algorithm.

FILTER NAME	PSNR(DB)	MSE
2D AMA	23.13	31.56
2D LGF	28.72	8.7
2D FWD	22.24	38.75
2D IDABF	42.72	0.475

Table 1. Comparison of PSNR and MSE for different filtering algorithms using Covid-19 CT lung image

CONCLUSION

In this research, novel algorithm is proposed for the pre-processing of medical lung CT images. A new algorithm called 2D Improved Anisotropic Diffusion Bilateral Filter (2D IADBF) was proposed for the effective filtration of CT images. This scheme was designed such that the noise components of the image were completely removed with the simultaneous retention of gradient details. This system was modelled based on the union of bilateral filter and the anisotropic diffusion model. It was inferred that the proposed 2D IADBF filtration algorithm achieved minimal processing time of 13ms and 12.3ms for Covid-19 images respectively. Further, the RMSE of the 2D IADBF filtration algorithm was as low as 0.005 and 0.0023 for the Covid-19 CT images respectively.

Future work

In future, it is possible to design algorithms for the enhancement, segmentation and classification of these images for the effective diagnosis of Covid-19

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