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Image Denoising Using PCA Filtering and Image Convolution

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ABSTRACT

The Denoising of an image occurs in proportion to the noise intensity prevalent in an image. The first step of Denoising is to estimate the noise in image by detecting the type of noise. The Denoising is done in two forms i.e. spatial and frequency. The spatial domain utilizes the variation in variance intensity of noise signal and change to estimate the mean error weights. The issue in previous work was the non-local estimations of noise when applying total variation filter in an image with Gaussian noise. The NLM constituted global mean values to estimate the filter intensity threshold for subsidizing the noise. The base approach was non-consistent due to the noise separation being a function of global variation estimation and the overall Denoising depends on single block variance values. The proposed system used the non-local and local state of filter based on frequency decompose image analyzed under principle component filter. The principle component extractor uses the frequency change occurring due to noise change in image data. This preserved actual image data from being over saturated due to non-linear filtering. The experimental results show the validation of the proposed system on the basis of PSNR and MSE estimation. It can be observed that the proposed filter can be better than the previous filter.

Keywords- *NLM, Wavelet, PCA, SNR, MSE, MRI.*

1. Introduction

Importance of Images

Now a days, Images are one of the most popular way of convey information in modern science and technologies, for e.g. in the medical field, communication, military purposes etc. So, It is very important that images should be of high quality and should not be affected because of any reasons.

Images are often corrupted during acquisition and transmission, which could convey improper information. To improve the image quality, Denoising and Deblurring are the essential steps. In the field of Biomedical, images play very important role where quality of an image can't be compromised. Like in Magnetic Resonance Imaging(MRI), is one of the popular technique for image diagnosis and it is preferred over other medical imaging modalities because it does not provide any harmful radiation , but in this also, the quality of digital medical images become an important issue. To get best result, It is necessary that medical images should be sharp, free of noise and clear. The major challenge is removing noise in these digital images. Thus, denoising and deblurring is the first step to be taken before the image data is analyzed.

In this paper, we propose a better denoising algorithm, based on PCA that is easy to understand.

PCA

PCA (Principal component analysis) directly applies on noisy image without data selection and many visual artifacts and noise residual will appear in the denoised outputs [1].

NLM

The NLM (Non local means) is a kind of an averaging filter in the sense that it uses the weighted average of the neighbourhood pixels and replaces the pixel value under consideration [2].

Speckle Noise

Speckle noise [3] is observed in ultrasound images whereas Rician noise [4] affects MRI images.

Salt and Pepper Noise

Salt and Pepper noise [5] is an impulse type of noise and is also referred to as intensity spikes. It is generally caused due to errors in transmission. This is caused generally due to errors in the data transmission.

2. LITERATURE REVIEW

There are so many methods for removing the noise from normal and medical images. From the recent years, various methods have been suggested for increasing medical image's quality. Image Denoising, using different-different filters, is widely used in recently years. The field of medical image Denoising is an important aspect of medical image processing, because of their huge applications in many areas of our life special in the medical diseases diagnosis. Magnetic Resonance Imaging (MRI) , is one of the popular technique for image diagnosis. Many articles and Literature Review are published in this field and we will explain some of these works.

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The image restoration Process has a quite long history that began in the 1950s with the space program. The first images of the Earth, Moon (mainly of the opposite side), and planet Mars were, at that time of unimaginable resolution. The images were obtained under big technical difficulties, such as vibrations, bad pointing, motion due to spinning, etc. These difficulties resulted, in medium to large degradations that could be scientifically and economically devastating. The need to restore as much information as possible from such degraded images was the aim of the early efforts to adapt the one-dimensional signal processing algorithms to images, creating a new field that is today known as Digital Image Restoration and Reconstruction. The application of early image restoration techniques to these images was very successful. If we compare the raw data obtained by the spacecraft with the "final" products it can be easily predicted that they were obtained using different equipment and in different epochs. Since 1950's, the techniques of Image and Video Reconstruction and Restoration have been useful in all scientific Methods. The Application Domains of image and Video Restoration and Reconstruction are
scientific explorations, Legal Investigations, Film Making, Image and Video Denoising and Consumer Photography.
In 1990's something happened that changed the situation of image restoration in the field of optical astronomy. After the launch of the $2000 million Hubble Space Telescope (HST), an cureless mistake was discovered in the main mirror. The mirror had a severe problem of spherical aberration because it was polished with the help of a faulty device and checked with the same faulty device. Thus, the checking was perfectly coherent with the polishing but the curvature of the mirror was wrong. Since a single minute of observing telescope time cost about $100,000, any effort to improve the images was cheap. Since then, a substantial amount of work has been done in image restoration. As result of such efforts and with the developing technology, it was possible to correct the highly corrupted images and videos.

3. Problem Solved

To design and implement a model for image noise reduction using Principle Component Denoiser

a. The PCA analyzer convert the image signal into frequency or transfer domain and then differentiate or abstracts the principle frequency and individual noise frequency and differentiate between them by tracking the non-linear or impulse type frequency response. This helps to suppress only the noisy part of the image data and reduce the application of filter on image data.
b. This is backed up by calculation of mean variance change in the post filtered image.
c. The mean variance continue to change the threshold applied filter till the total number of user entered iteration are complete.

4. Working of Principle Component Denoiser

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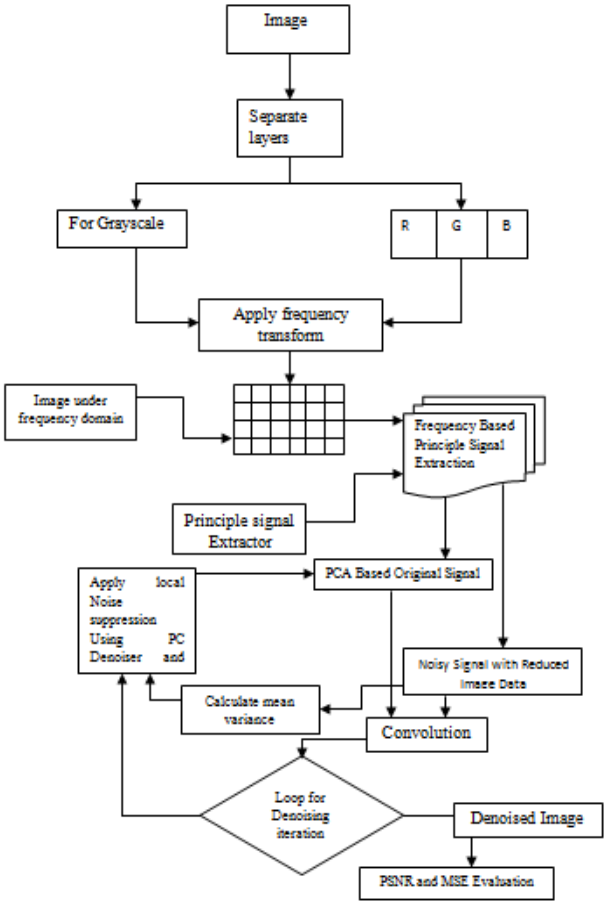

Figure 1 shows the PCA Denoiser Work Flow

b. This is backed up by calculation of mean variance change in the post filtered image.

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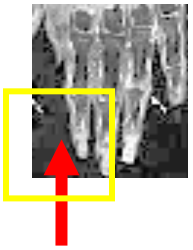
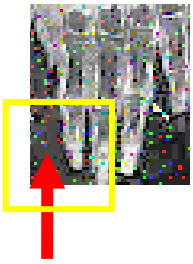
c. The mean variance continue to change the threshold applied filter till the total number of user entered iteration are complete.
After the completion of the filtration the image is converted back into spatial domain from its frequency of transform domain. After that the PSNR and MSE of the image is conducted.

5. Results and Discussion

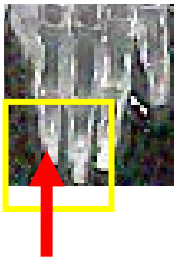
The above figure shows the output of the proposed filter and the below section shows the zoomed in output of the fingers.



Original Part



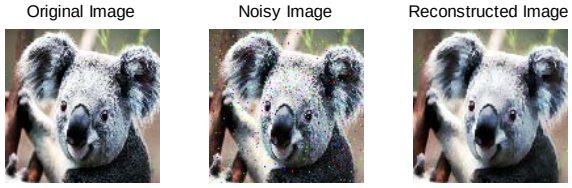
UnderNoise



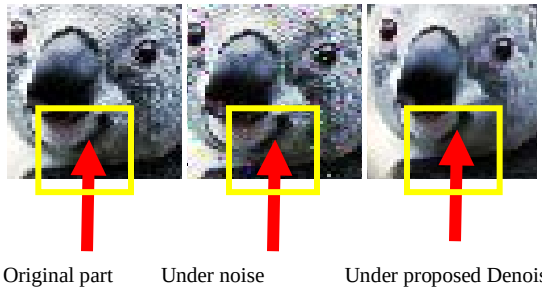
Under Proposed Denoising

Fig. 2 Comparison of proposed filter with previous filter

The above figure shows the comparison of proposed filter. It can be seen from the first figure that the highlighted by yellow window. The second image shows the highlighted area of the fingers that is under noise. Third image show the output section of the fingers after elimination of the noise.



The above figure shows the output of the proposed filter and the below section shows the zoomed in output of the koala.



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The below given table shows the difference in the performance of the base and proposed system.

		PSNR	***RMSE***
BASE	Before	17.15664	0.138729
	After	26.89534	0.04521
PROPOSED	Before	18.64907	0.116828
	After	27.88455	0.039236

Table 1.Shows PSNR and MSE values of Base and Proposed

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6. CONCLUSION

The previous system had some problems in image Denoising as the wavelets removed the necessary details of the edge ad reduced the clarity of the restored image, the observation was carried out with some quality metrics like PSNR and MSE. The metric values have shown a difference of 3 to 4 dbs projecting improvisation beyond the limit of the wavelet as well as NLM system of Denoising. The robustness of the proposed system is shown in both the general and medical images; the experiment al analysis showed the enhancement provided by the PCA based denoiser. In future the proposed system can be used as a substitute for low end noise prone image data, which needs fast economic processing.

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