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An Overview of Image Denoising and Image Denoising Techniques

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Abstract—*Image Denoising is a great challenge in the field of image processing now days. Many algorithms have been developed for image denoising but it continues to be an active challenge for the researchers. Images are often received in defective conditions due to poor scanning and transmitting devices. Consequently, it creates problems for the subsequent process to read and understand such images. Therefore, it becomes extremely important to remove the noise before applying them to any image processing action. Many algorithms have been developed in this regard and all of them have their own merits and demerits. The selection of these algorithm depends on the type of application and the noise present in the image. This paper sites the various image denoising techniques.*

Keywords*: Image Denoising, Spatial Domain Filtering, Linear Filters, Non- Linear Filters Transform Domain Filtering.*

1. INTRODUCTION

One of the fundamental challenges in the field of image processing and computer vision is image denoising, where the underlying goal is to estimate the original image by suppressing noise from a noise-contaminated version of the image. Image noise may be caused by different intrinsic (i.e., sensor) and extrinsic (i.e., environment) conditions which are often not possible to avoid in practical situations. Therefore, image denoising plays an important role in a wide range of applications such as image restoration, visual tracking, image registration, image segmentation, and image classification, where obtaining the original image content is crucial for strong performance. While many algorithms have been proposed for the purpose of image denoising, the problem of image noise suppression remains an open challenge, especially in situations where the images are acquired under poor conditions where the noise level is very high.

Image denoising problem is still a difficult task for the researchers because removal of noise causes the artifacts and image blurring. This paper provides different methodologies for noise reduction and gives us also the insights into the methods to determine which method will provide the reliable and approximate estimate of original image given its degraded version. Modeling of noise is dependent on several factors such as data capturing instruments, transmission media, and quantization of image and discrete sources of radiation. Depending on the noise model, different algorithms can be used.

2. IMAGE DENOISING

Basically, Image Denoising is the recovery of the digital image that is affected by noise. In case of image denoising methods, the characteristics of the degrading system and the noises are assumed to be known beforehand [5]

The image a(x, y) is blurred by a linear operation and noise n(x, y) is added to form the degraded image b(x, y). This is convolved with the restoration procedure g(x, y) to produce the restored image c(x, y). The Linear operation shown in Fig. (1) is the addition or multiplication of the noise n(x, y) to the signal a(x, y).

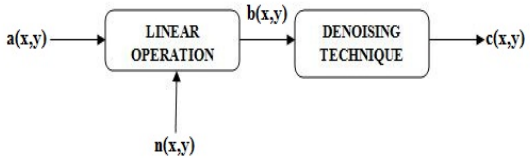

Fig. 1: Denoising Concept

Once the corrupted image b(x, y) is obtained, it is subjected to the denoising technique to get the denoised image c(x, y) [5]

3. TECHNIQUES OF IMAGE DENOISING

Various denoising techniques have been proposed so far and their application depends upon the type of image and noise present in the image [5]. Objectives of any filtering approach are:

- To suppress the noise effectively in uniform regions.
- To preserve edges and other similar image characteristics.
- To provide a visually natural appearance

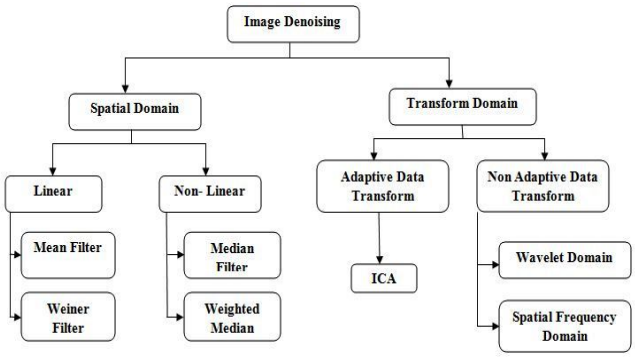

Fig. 2: Image Denoising Techniques

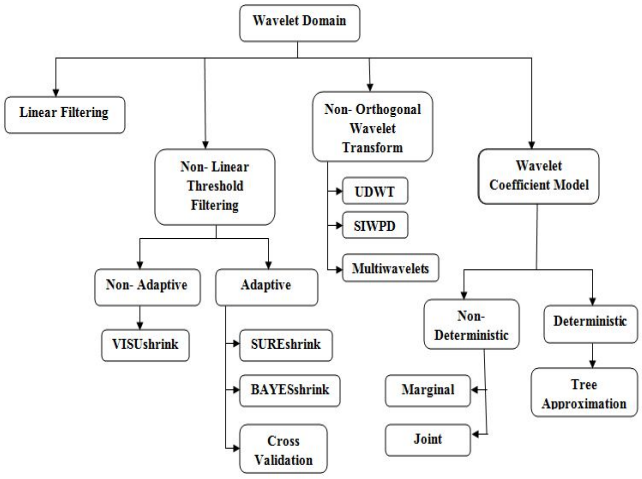

Fig. 3: Classification of Wavelet Domain Filtering Technique

4. SPATIAL DOMAIN FILTERING

A traditional way to remove noise from image data is to employ spatial filters.

Spatial filtering is the method of choice in situations when only additive noise is present.

Spatial filters can be further classified into non linear and linear filters [6]

4.1 Non- Linear Filters: In recent years, a variety of non-linear median type filters such as rank conditioned, weighted median, relaxed median, rank selection have been developed to overcome the shortcoming of linear filter. With the non-linear filter, noise is removed without any attempts to explicitly identify it [2].

4.2 Linear Filters: Linear filters also known as average filter are generally of two types: mean filter and wiener filter Linear filters too tend to blur sharp edges, destroy lines and other fine image information, and execute poorly in the presence of signal dependent noise [2]

5. TRANSFORM DOMAIN FILTERING

The transform domain filtering methods can be subdivided according to the choice of the basis functions. The basis functions can be further classified as data adaptive and non-adaptive.

5.1 Adaptive Data Transform: Independent component analysis (ICA) transformation methods recently gain more importance include key component analysis, factor analysis, and projection detection. ICA most extensively used method for blind source partition problem. One advantage of using ICA is it's assumption of signal to be Non - Gaussian which helps denoising of images with Non- Gaussian as well as Gaussian distribution. Some applications of ICA method are machine fault detection, seismic monitoring, reflection cancelling, finding hidden factors in financial data text document analysis, radio communications, audio signal processing, image processing, data mining, time series forecasting, defect detection in patterned display surfaces, bio medical signal processing.

Disadvantage of ICA based methods is the computational cost because it uses a sliding window and it involves sample of at least two image frames of the same scene

5.2 Non- Adaptive Data Transform: This method has been classified into: wavelet Domain Filtering and Spatial Frequency Domain

(a) Spatial Frequency Filtering:

It refers the use of low pass filters using fast Fourier Transform. The noise is removed by deciding a cutoff frequency and adapting a frequency domain filter when the components of noise are decorrelated from useful signal. The main disadvantage of Fast Fourier Transform (FFT) is the fact that the edge information is spread across frequencies because of FFT basis function and it is not being localized in time or space which means that time information is lost and hence low passes filtering results in smearing of the edges [7]

(b) Wavelet Domain Filtering

Working in Wavelet domain is preferred because the Discrete Wavelet Transform (DWT) make the signal energy concentrate in a small number of coefficients, hence, the DWT of the noisy image consists of a small number of coefficients having high Signal to Noise Ratio (SNR) while relatively large number of coefficients is having low SNR. After removing the coefficients with low SNR (i.e., noisy coefficients) the image is reconstructed by using inverse DWT. As a result, noise is removed or filtered from the observations. A major advantage of Wavelet methods is that it provides time and frequency localization simultaneously. Moreover, wavelet methods characterize such signals much more efficiently than either the original domain or transforms with global basis elements such as the Fourier transform [5]

6. CONCLUSION

In this paper, numerous amounts of Image Denoising Techniques are discussed.

The selection of Denoising technique depends on what kind of denoising is required. Further, it depends on what kind of information is required the mentioned methods can be implemented that to look how it can be used on different images. With different spatial resolution, different behaviors of same image would be quite interesting. Since selection of the right denoising procedure plays a major role, it is important to experiment and compare the methods

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