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Review Paper on Image Denoising Techniques

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Abstract - *In various fields and applications use of images is becoming increasingly popular like in field of medical, education etc. Problem that arises after denoising process is the destruction of the image edge structures. For this there are several techniques proposed by other authors for image denoising as well as edge preservations. In these paper, we aim to provide a review of some of those techniques that can be used in image denoising. This paper outlines the brief description of noise, types of noise, image denoising and then the review of different techniques and their approaches to remove that noise. The aim of this review paper is to provide some brief and useful knowledge of denoising techniques for applications using images to provide an ease of selecting the optimal technique according to their needs.*

Key Words: **Image denoising, Gaussian noise, Salt-&-Pepper noise, Poission noise, MMSE, PSNR.**

1. INTRODUCTION

Visual information transmitted in the form of digital images is becoming a major method of communication in the modern age, but the image obtained after transmission is often corrupted with noise. Noise is the result of errors in image acquisition process that result in pixel values that do not reflect the true intensities of the real scene. The received image needs processing before it can be utilized as an input for decision making. Image denoising involves the manipulation of the image data to produce a visually high quality image. Different noise models including additive and multiplicative types are used e.g gaussian noise, salt and pepper noise and Poisson noise. Selection of the denoising algorithm is application dependent therefore, it is necessary to have knowledge about the noise present in the image so as to select the appropriate denoising algorithm. The filtering approach has been proved to be the best when the image is corrupted with salt and pepper noise. The scope of the paper is to focus on noise removal techniques for natural images using statistical and non statistical method.

1.1 TYPES OF NOISE

Gaussian noise – One of the most occurring noise is Gaussian noise. Principal sources of Gaussian noise arise during

acquisition e.g. sensor noise caused by poor illumination and/or high temperature, and/or transmission e.g. electronic circuit noise. Gaussian noise represents statistical noise having probability density function (PDF) equal to that of the normal distribution, which is also known as the Gaussian distribution. In other words, the values that the noise can take on are Gaussian-distributed. The probability density function of a Gaussian random variable z is given by:

$$p_G(z) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(z-\mu)^2}{2\sigma^2}}$$

Where z represents the grey level μ the mean value and σ standard deviation. The standard model of this noise is additive, independent at each pixel and independent of the signal intensity, caused primarily by thermal noise. The mean of each distributed elements or pixels of an image that is affected by Gaussian noise is zero. It means that Gaussian noise equally affects each and every pixel of an image.

Salt-and-pepper noise – Fat-tail distributed or "impulsive" noise is sometimes called salt-and-pepper noise. Any image having salt-and-pepper noise will have dark pixels in bright regions and bright pixels in dark regions. In salt-and-pepper noise corresponding value for black pixels is 0 and for white pixels the corresponding value is 1. Hence the image affected by this noise either have extreme low value or have extreme high value for pixels i.e., 0 or 1.Given the probability r (with 0<= r<=1) that a pixel is corrupted, we can introduce salt-and-pepper noise in an image by setting a fraction of r/2 randomly selected pixels to black, and another fraction of r/2 randomly selected pixels to white. This type of noise can be caused by analog-to-digital converter errors, bit errors in transmission, etc. Elimination of salt-and-pepper noise can be done by using dark frame subtraction and interpolating around dark/bright pixels.

Poission noise- This noise is seen due to the statistical nature of electromagnetic waves such as x-rays, visible lights and gamma rays. The x-ray and gamma ray sources emitted number of photons per unit time. These sources are having random fluctuation of photons. Result gathered image has spatial and temporal randomness. In the lighter parts of an image there is a dominant noise from an image sensor which is typically caused by statistical quantum fluctuations, that is, variation in the number of photons sensed at a given exposure level called photon shot noise. Shot noise follows a Poisson distribution, which is somehow similar to Gaussian.

2. PROPOSED METHOD

In this paper we propose to use image denoising by using statistical and non statistical methods. Fig 1. shows the block diagram of the proposed method.

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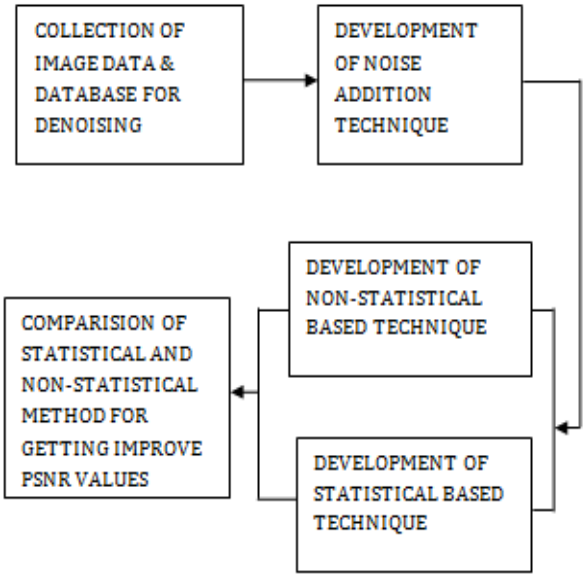

FIG-1: Block Diagram of Proposed Method

As shown in the block diagram first the image is divided into sub blocks then each sub block is given to a statistical processor which find out the parameter for the blocks. These parameter will defer for noisy & non noisy blocks. This difference help us to identify the block which have noise. These block will replaced with the information or knowledge from neighbouring blocks. Our approach will be statistical approach, where we will first evaluate nature of noise by gathering the knowledge from the nearby pixel and then refine the amount of noise present in the image, this will help for denoising of image irrespective on the noise.

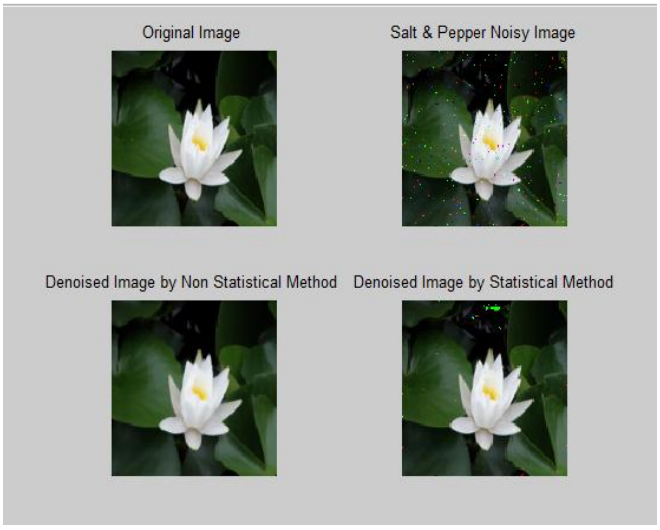

FIG-2: Comparision of Denoised Image Using Non Statistical & Statistical Method

As shown in Fig 2, first we add the noise such as salt and pepper noise, then we apply the non- statistical parameter we got the blur image. Also apply the statistical parameter to the noisy image, we got the image similar to the original image. By applying non statistical parameter PSNR decreases and MMSE increases & by applying statistical parameter PSNR increases and MMSE decreases.

2.1 NOISE REMOVING TECHNIQUES

Median Filtering–Median filter is a simple and powerful non-linear filter which is based on order statics, whose response is based on the ranking of pixel values contained in the filter region. It is easy to implement method of smoothing images. The median filter also follows the moving window principle similar to the mean filter. A 3*3, 5*5, or 7*7 kernel of the pixels is scanned over pixel matrix of the entire image. In this filter, we do not replace the pixel value of the image with the mean of all neighboring pixel values; we replace it with the median value. Median filtering is done by, first sorting all the pixel values from the surrounds neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value.

Adaptive Filtering- Adaptive filter is performed on the degraded image that contains original image and noise. The mean and variance are the two statistical measures that a local adaptive filter depends with a defined mxn window region. The adaptive filter is more selective than a comparable linear filter, preserving edges and other high-frequency parts of an image. The wiener2 function applies a Wiener filter (a type of linear filter) to an image adaptively, tailoring itself to the local image variance. Where the variance is large, wiener2 performs little smoothing. Where the variance is small, wiener2 performs more smoothing. Another method for removing noise is to evolve the image

under a smoothing partial differential equation similar to the heat equation which is called anisotropic diffusion.

Wiener Filter: The main aim of this technique is to filter out noise that has corrupted the signal. It is kind of statistical approach. For the designing of this filter one should know the spectral properties of the original signal ,the noise and linear time-variant filter whose output should be as close as to the original as possible. The Wiener filter minimizes the mean square error between the estimated random process and the desired process.

3. CONCLUSIONS

In this paper various performance parameters are discussed which are used to compare the effectiveness of filtering techniques. Mostly Peak signal-to-noise ratio parameter is used for measuring the effectiveness of any filter. The higher PSNR, gives the better quality of image. Each filter work differently on different types of noises. Median filter works well for Salt and Pepper noise where as wiener filter works well for removing Poisson noise.

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