Gaussian Noise Removal by a New Approach of Discrete Wavelet Transform

Pooja Pandey
M.Tech Scholar
Dr.C.V. Raman University

Praveen Chouksey
ASST.PROF CSE DEPT
Dr. C.V. Raman University

***Abstract*— The search for efficient image denoising methods still is a valid challenge, at the crossing of functional analysis and statistics. In spite of the sophistication of the recently proposed methods,most algorithms have not yet attained a desirable level of applicability. All show an outstanding performance when the image model corresponds to the algorithm assumptions, but fail in general and create artefacts or remove image fine structures.Removing noise from the original signal is still a challenging problem for researchers. There have been several published algorithms and each approach has its assumptions, advantages, and limitations. This paper presents a review of some significant work in thearea of image denoising. After a brief introduction, some popular approaches are classified into different groups and an overview of various algorithms and analysis is provided. Insights and potential future trends in the area of denoising are also discussed.**

***Index Terms*—** Image denoising **,** *DWT (Discrete wavelet transform)*

I. INTRODUCTION

Image processing is a field that continues to grow, with new applications being developed at an ever increasing pace. It is a fascinating and exciting area to be involved in today with application areas ranging from the entertainment industry to the space program. One of the most interesting aspects of this information revolution is the ability to send and receive complex data that transcends ordinary written text. Visual information, transmitted in the form of digital images, has become a major method of communication for the 21st century. Historically, the field of image processing grew from electrical engineering as an extension of the signal processing branch. The massive amount of data required for images is a primary reason for the development of many sub areas within the field of computer imaging such as image segmentation and compression.

Denoising is very important in image processing because the noise will not only affect the image quality but also affect the visual performance .For example under low light levels, it is difficult to accurately estimate scene depths using noisy stereo images. This image processing field is continuously growing day by day new applications are developing. This is the are that involved today with application areas ranging from the entertainment industry to the space program. Today images has become a major method of communication and this images are very easy to transform from one place to the another but it is very challenging to transfer the original image without noisy image. White noise is one of the major problems that is presented in the field of image processing. Most denoising algorithms make two assumptions about the noisy image. These assumptions can cause blurring and loss of details in the resulting denoised images. First assumption is that the white noise will be there in image that means noise contained all frequencies, low and high. Because of the higher frequency noise is non smooth. Second assumption is that the true image is smooth and for getting the smooth image we need the lower frequencies.De-noising of natural images corrupted by noise using wavelet techniques is very effective because of its ability to capture the energy of a signal in few energy transform values. The wavelet de-noising scheme thresholds the wavelet coefficients arising from the wavelet transform. The wavelet transform yields a large number of small coefficients and a small number of large coefficients.

Previous method of image de-noising based on this assumption that they try to separate the smooth image and for that they try to convert the high frequency to the lower frequency. But it is impossible to get the smooth image always and this is the big challenge for all the de-noising process and this is very motivational part of this.Image processing is any form of signal processing for which the input is an image, such as photographs or frames of video and the output of image processing can be either an image or a set of characteristics or parameters related to the image. Most image processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it.

There are applications in image processing that require the analysis to be localized in the spatial domain. The classical way of doing this is through what is called Windowed Fourier Transform. Central idea of windowing is reflected in Short Time Fourier Transform (STFT). The STFT conveys the localized frequency component present in the signal during the short window of time.

The image usually has noise which is not easily eliminated in image processing. According to actual image characteristic, noise statistical property and frequency spectrum distribution rule, people have developed many methods of eliminating noises, which approximately are divided into space and transformation fields The space field is data operation carried on the original image, and processes the image grey value, like neighborhood average method, wiener filter, center value filter and so on. The transformation field is management in the transformation field of images, and the coefficients after transformation are processed.

Denoising or estimation of functions, involves reconstituting the signal as well as possible on the basis of the observations of a useful signal corrupted by noise.The methods based on wavelet representations yield very simple algorithms that are often more powerful and easy to work with than traditional methods of function estimation. It consists of decomposing the observed signal into wavelets and using thresholds to select the coefficients, from which a signal is synthesized. Image de-noising algorithm consists of few steps;

ISSN: 2278 – 7798

Process of De-noising

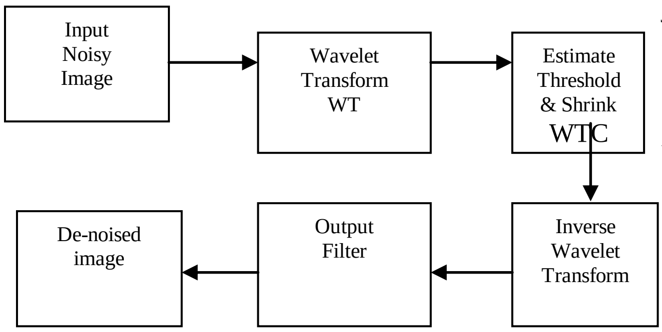

Figure 1: Block diagram of Image de-noising using wavelet transform.

II. LITERATURE SURVEY

In this section literature survey is presented under two heads noise removal and prevention of noise boosting in contrast enhancement. Noise removal from a contaminated image signal is still a challenging problem for researchers. Many researchers have suggested a large number of algorithms and compared their results.The main thrust on all such algorithms is to remove impulsive noise while preserving image details. These schemes differ in their basic methodologies applied to suppress noise. Some schemes utilize detection of impulsive noise followed by filtering whereas others filter all the pixels irrespective of corruption. In this sectionan attempt has been made for a detail literature review on the reported articlesand study their performances through computer simulation. We have classified the schemes based on the characteristics of the filtering schemes and described are below.We also describe some of the conventional contrast enhancement techniques in this section, boosting in images can be prevented with proper

Impulsive Noise Removal

A. Filtering without Detection
In this type of filtering a window mask is moved across the observed image.The mask is usually of size (2*N*+1)2, where *N* is a positive integer. Generallythe center element is the pixel of interest. When the mask is moved starting from the left-top corner of the image to the right-bottom corner, it performs some arithmetical operations without discriminating any pixel.

B. Detection followed by Filtering
This type of filtering involves two steps. In first step it identifies noisy pixels and in second step it filters those pixels. Here also a mask is moved acrossthe image and some arithmetical operations is carried out to detect the noisypixels. Then filtering operation is performed only on those pixels which are found to be noisy in the previous step, keeping the non-noisy intact.

C. Hybrid Filtering
In such filtering schemes, two or more filters are suggested to filter a corrupted location. The decision to apply a particular filter is based on the noise level at the test pixel location or performance of the filter on a filtering mask.

III. PROBLEM IDENTIFICATION

Different types of noise frequently contaminate images. Impulsive noise is one such noise, which may affect images at the time of acquisition due to noisy sensors or at the time of transmission due to channel errors or in storage media due to faulty hardware.

Two types of impulsive noise models are described below.

Let Yi,j be the gray level of an original image Y at pixel location (i, j) and[n min, n max] be the dynamic range of Y. Let Xi,j be the gray level of the noisy image X at pixel (i, j) location.
Impulsive Noise may then be defined as:
$X_{i,j} = \begin{cases} Y_{I,j} & \text{with } 1-p \\ R_{I,j} & \text{with } p \end{cases}$ where, Ri,j is the substitute for the original gray scale value at the pixel location (i, j). When R i,j ∈ [n min, n max], the image is said to be corrupted with RandomValued Impulsive Noise (RVIN) and when R I ,j ∈ {n min, n max}, it is known as Fixed Valued Impulsive Noise or Salt & Pepper Noise (SPN).The difference between SPN and RVIN . In the case of SPN the pixel substitute in the form of noise may be either n min(0) or n max(255). Where as in RVIN situation it may range from n min to n max. Cleaning such noise is far more difficult than cleaning fixed-valued impulse noise since for the latter, the differences in gray levels between a noisy pixel and its noise-freeneighbors are significant most of the times. In this thesis, we focus only on randomvalued impulse noise (RVIN) and schemes are proposed to suppress RVIN.One common drawback of typical image sharpening (enhancement) methods is that they tend to boost noise while amplifying the image details making the image more noisy. This undesirable amplification limits the real time applications of sharpening algorithms. Typical solution to deal with noise amplification whenperforming enhancement is perform noise reduction prior to enhancement. However, noise filters not only suppress noise but also tend to blur the image details producing low quality images . This is because noise reduction is commonly a low pass filtering operation, whereas sharpening is a high-pass operation. Hence,there is a conflicting spectral demand on both filters, and generally, the optimization of one leads to deterioration of the other

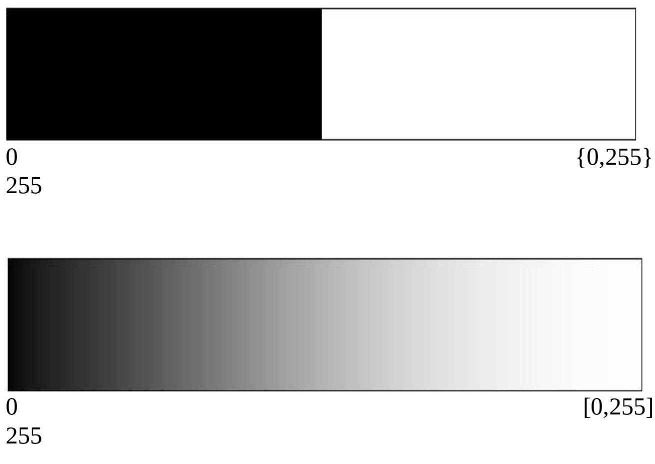

Figure: Representation of (a) Salt & Pepper Noise with Ri,j ∈ {nmin, nmax},(b) Random Valued Impulsive Noise with Ri,j ∈ [nmin, nmax]

IV. PROPOSED METHODOLOGY

The hard and soft thresholding method is used to Compose the noisy data into an orthogonal wavelet basis in order to suppress the wavelet coefficients to be smaller than the given amplitude and to transform the data back into the original domain [8] [9]. One original image is applied with Gaussian noise with variance. The methods proposed for implementing image de-noising using Shift Invariant wavelet transform take the following form in general. Estimate the Threshold using 'sureshrink' Sure Shrink

ISSN: 2278 – 7798

suppresses noise by thresholding the empirical wavelet coefficients. Sure Shrink follows the soft thresholding rule. The thresholding employed here is adaptive. A threshold level is assigned to each dyadic resolution level by the principle of minimizing the Stein's Unbiased Risk Estimator for threshold estimates. This method is much better than VisuShrink. The sharp features of image are retained and the MSE is considerably lower. This because Sure Shrink is sub band adaptive [10]. This section describes the image denoising algorithm, which achieves near optimal soft thresholding in the wavelet domain for recovering original signal from the noisy one. The algorithm is very simple to implement and computationally more efficient. It has following steps:

1. Read the original standard image.
2. Resize the loaded image to a standard size of 256 × 256. For large sized images, such as 512× 512, the computation time for denoising is found to be more. And if the image size is taken smaller than 256× 256, then the useful data is liable to get lost.
3. Add Gaussian Noise of given mean and variance is added to given standard Image.
4. The image is transformed into the orthogonal domain by taking the wavelet transform.
5. Estimate the Threshold using 'sureshrink'. (Threshold selection using principle of Stein's Unbiased Risk Estimate). The sureshrink threshold t* is defined as t* = min (t, $\sigma\sqrt{2\log n}$). Where t* denotes the value that minimize Stein's Unbiased Risk Estimator, σ is the noise variance, and n is the size of the image.
6. Perform N Level Shift Invariant Wavelet Decomposition of Image using given Wavelet.
7. Apply Soft or Hard Thresholding on Decomposed Wavelet Coefficients.
8. Perform N Level Inverse Shift Invariant Wavelet Transform using given Wavelet.
9. Calculate the PSNR and MSE

V. PERFORMANCE MEASURE

The metrics used for performance comparison of different filters (exists and proposed)
are defined below.

a. Peak Signal to Noise Ratio (PSNR)

PSNR analysis uses a standard mathematical model to measure an objective difference between two images. It estimates the quality of a reconstructed image with respect to an original image. The basic idea is to compute a single number that reflects the quality of the reconstructed image. Reconstructedimages with higher PSNR are judged better. Given an original image Y ofsize (M×N) pixels and a reconstructed image ˆ y

b. Percentage of Spoiled Pixels (PSP)

PSP is a measure of percentage of non-noisy pixels change their gray scale
values in the reconstructed image. In other words it measures the efficiency
.

c. Subjective or Qualitative measure

Along with the above performance measure subjective assessment is also required to measure the image quality. Unavailability of quantitative performance measure in case of image enhancement (sharpening) subjective or qualitative measure is the only option left for measurement . In a subjective assessment measures characteristics of human perception become paramount, and image quality is correlated with the preference of an observer or the performance of an operator for some specific task. Hence as an usual case of image enhancement there is no quantitative performanceevaluation measure because no ideal image can be used as reference. Anyreasonable measure should be tuned to the human visual system. Howeverperceptual quality evaluation is not a deterministic process. So subjectiveevaluation is the only way to prove the performance. Hence human observeris the only way by which enhanced image quality can be measured. All theproposed schemes are hence compared with the subjective results of well accepted schemes.

VI. CONCLUSION

In image de-noising, Adaptive Thresholding performed better performance in both PSNR and visual quality than wavelet de-noising (hard thresholding or soft thresholding). The PSNR performance and visual quality can be enhanced by using Translation invariant method. Translation invariant capability of attenuating Gibbs oscillation and adaptation to discontinuities gave an advantage to provide better result.

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ISSN: 2278 – 7798