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Noisy Image Enhancement Analysis in SVD-DWT

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***Abstract*— In this paper, Image de-noising is a classical yet fundamental problem in low level vision, as well as an ideal test bed to evaluate various statistical image modeling methods. In this, spatial and frequency domain technique are used.in spatial domain svd (singular value decomposition) is elaborated. The Singular Value Decomposition (SVD) is a traditional tool used in 2-dimensional grey scale image processing.in the frequency domain, dwt is expanded. Over the past decade, wavelet transforms have received a lot of attention from researchers in many different areas. Both discrete and continuous wavelet transforms have shown great promise in such diverse fields as image compression, image de-noising, signal processing, computer graphics, and pattern recognition to name only a few.**

KEY WORDS
Types of noise, image de-noising, spatial domain technique, frequency domain technique, Algorithm.

I. INTRODUCTION

Image de-noising is to estimate the latent Clean image **x** from its noisy observation **y**. One commonly used observation model is **y** = **x** + **v,** where **v** is additive white Gaussian noise. Image de-noising is a classical yet still active topic in image processing and low level vision, while it is an ideal test bed to evaluate various statistical image modeling methods [1].

Image de-noising is the process of removing noise from images. It has remained a fundamental problem in the field of image processing. Digital images play an important role in daily life applications like satellite television, magnetic resonance imaging, computer tomography, geographical information systems, astronomy and many other research fields [3]. While we cannot completely avoid image noise, we can certainly reduce them. The image noise is removed usually by image smoothing operation.

There are two basic methodologies to image de-noising, viz. spatial domain technique and frequency domain technique. Spatial domain operate on a set of pixels related to a given pixel, usually by a sliding window. The window (or kernel) is typically square but it can be any shape. Transform domain filters, in general, change the basis of signal space to aid some processing on the image data [2]. Examples of frequency domain technique are Fourier transform and wavelet transform.

II TYPES OF NOISE

A Amplifier noise (Gaussian noise)[12]

The standard model of amplifier noise is additive, Gaussian, independent at each pixel and independent of the signal intensity, caused primarily by Johnson–Nyquist noise, as well as that which originates from the rearrange noise of capacitors. Amplifier noise is a main part of the "read noise" of an image sensor, that is, of the unchanged noise level in dark areas of the image.

Gaussian noise:

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

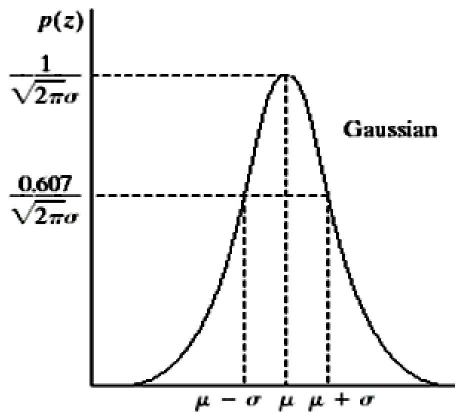

Fig. 1 Gaussian Noise Graph

B Salt-and-pepper noise[12]

Heavy tail distribution or "burst" noise is often known as salt-and-pepper noise. An image accommodate salt-and-pepper noise will have dark picture elements in bright regions and bright picture elements in dark regions. This type of noise can be caused by analog-to-digital converter errors, bit errors in transmission, etc. It can be mostly eliminated by using dark frame subtraction and interpolating around dark/bright pixels.

C Shot noise[12]

The prevalent noise in the lighter parts of an image from an image sensor is typically that produce by statistical quantum variation, that is, deviation in the number of photons sensed at a given disclosure level. This noise is known as Poisson noise. Shot noise has a root-mean-square value corresponding to the square root of the image strength, and the noises at various pixels are separate of one another. Shot noise pursues a Poisson distribution, which is not very different from Gaussian.

D. Quantization noise (Uniform Noise)[12]

The noise is generated by quantizing the pixels of a distinguished image to a numeral of discrete levels is known as quantization noise. It has been just about uniform distribution. Motionless it can be signal dependent, and it will be signal independent if additional noise sources are vast adequate to cause irresolute, or if dithering is explicitly purposeful.

III IMAGE DENOISING METHODS

A Spatial Domain technique [7]

The term spatial domain mentions to the collective of pixels composing an image. Spatial domain approaches are events that function directly on these pixels. Spatial Domain procedures will be designated by the expression

$$G(x,y)= T[f(x,y)]$$

Where g(x,y) is an output image, f(x,y) is an input image and T is an operator on f (or a set of input images), defined over neighbourhood of (x,y).

Spatial domain techniques directly deal with the image pixels. These techniques are based on gray level mappings, where the type of mapping used depends on the criterion chosen for enhancement.

1). Singular value decomposition

The Singular Value Decomposition (SVD) is a Classical tool used in two-dimensional grey scale Image processing [4]. An image may be decomposed into a sum of rank one matrices (images) that can be termed as Eigen images. The eigenvectors (Eigen images) form an orthogonal basis for representation of individual images in the image set.

By the hypothesis of additive noise, the original image is frequently predictable to a lower rank approximation of the noisy image. This model implies that the largest eigenvalues are associated to the signal components and the lowest eigenvalues to the noise components. The threshold selection has been extended in several ways. In [5], the author suggests performing SVD filtering in specific sub bands of wavelet domain by adaptively selecting threshold based on the in-homogeneous nature of image, [6] and tries to find the relation between threshold and the sub-bands of image that is decor related by in DCT.

Recently, many deblurring algorithms contend that an over-complete illustration of the signal is Higher to image denoising. The main advantage of over-complete expansion mainly lies in suppression of the Gibbs phenomena. The conversion invariant denoising algorithm is accomplished by shifting the signal several times, denoising each shifted signal distinctly, shifting back and then averaging the outcome. Where the signals are shifted back and averaged these edge artifacts are averaged as well.

The overlap between successive windows accounts for the over-completeness, while the transform itself is typically orthogonal (e.g. the SVD).

2) SVD REVIEW

Any image of size $M \times N$ ($N \geq M$) can be treated as real-valued matrix X [2]. In repetition, in an additive noise model, we detect a matrix $A = X + E$, where E is a casual noise trepidation matrix of full rank. Matrix A can be decomposed uniquely as

$$A = USV^T = \sum_{i=1}^{R} \lambda_i A_i$$

Where U and V are orthogonal matrices and $S = diag\ (\lambda 1, \lambda 2\ ..., \lambda R\ , \lambda R{+}1, ..., \lambda N\ )$ is a diagonal matrix. The slanting elements of S can be decided in a descending instruction and are termed the singular values of A. Suppose that the first R singular values of A are introduced by a true signal, then the last $N - R$ singular values caused by noise can be small (but not necessarily zero). By setting zero to the "non-significant" singular values, we can estimate the true signal.

B. Frequency domain technique

Frequency domain techniques are based on the manipulation of the orthogonal transform of the image rather than the image itself. Transformation domain techniques are suited for processing the image according to the frequency content [10]. The principle behind the frequency domain methods of image enhancement consists of computing a 1-D discrete unitary transform of the image, for instance the 2-D DFT, manipulating the transform coefficients by an operator M, and then performing the inverse transform. The orthogonal transform of the image has two components magnitude and phase. The magnitude consists of the frequency content of the image. The phase is used to restore the image back to the spatial domain [5]. The usual orthogonal transforms are discrete cosine transform, discrete Fourier transform, Hartley Transform etc. The transform domain enables operation on the frequency content of the image, and therefore high frequency content such as edges and other subtle information can easily be enhanced.

1) *Discrete wavelet transform*

The Discrete Wavelet Transform (DWT) of image signals produces a non-redundant image representation, which provides better spatial and spectral localization of image formation, compared with other multi scale representations such as Gaussian and Laplacian pyramid.[11]

Recently, Discrete Wavelet Transform has attracted more and more interest in image de-noising. The DWT can be interpreted as signal decomposition in a set of independent, spatially oriented frequency channels.

The signal S is passed through two complementary filters and emerges as two signals, approximation and Details. This is called decomposition or analysis. The components can be assembled back into the original signal without loss of information. This process is called reconstruction or synthesis. The mathematical manipulation, which implies analysis and synthesis, is called discrete wavelet transform and inverse discrete wavelet transform. An image can be decomposed into a sequence of different spatial resolution images using DWT. In case of a 2D image, an N level decomposition can be performed resulting in 3N+1 different frequency bands namely, LL, LH, HL and HH as shown in figure 1. These are also known by other names, the sub-bands may be respectively called a1 or the first average image, h1 called horizontal fluctuation, v1 called vertical fluctuation and d1 called the first diagonal fluctuation. [11]

The sub-image a1 is formed by computing the trends along rows of the image followed by computing trends along its columns. In the same manner, fluctuations are also created by computing trends along rows followed by trends along columns. The next level of wavelet transform is applied to the low frequency sub band image LL only. The Gaussian noise will nearly be averaged out in low frequency wavelet coefficients. Therefore, only the wavelet coefficients in the high frequency levels need to be thresholded.

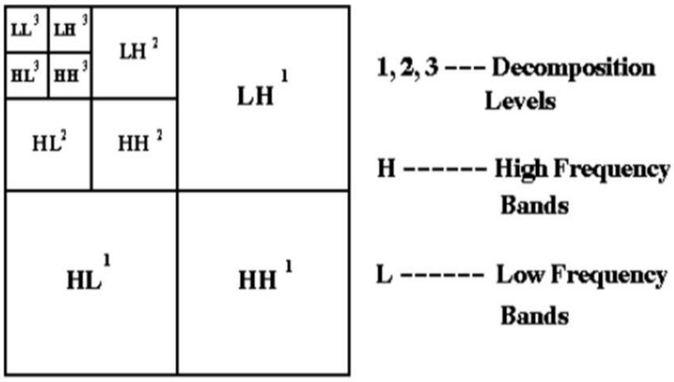

Fig. 2 2D-DWT with 3-Level decomposition

IV ADVANCEMENT IN PROPOSED ALGORITHM

In this section, we describe our iterative dual-domain algorithm. The goal is to estimate the original image x from a noise-contaminated image y = x + n with a stationary variance σ2 = Var (n). We observe that spatial domain methods excel at denoising high-contrast images while transform domain methods excel at low-contrast images. We therefore separate the image into two layers, and denoise them separately.

By using above technique, we can enhanced noisy image using software development tools .In singular value decomposition implies that the largest eigenvalues are associated to the signal components and the lowest eigenvalues to the noise components. The Discrete Wavelet Transform (DWT) analysis, is based on the assumption that the amplitude rather than the location of the spectra of the signal to be as diverse as probable from the amplitude of noise.

V CONCLUSION

In this paper different denoising techniques are discussed. The Techniques which are being available like singular value decomposition and discrete wavelet transform. As per the Reviewed paper, above stated technique can be useful for image de-noising with preservation of texture content, which will be carry forward as a part of future work. Comparison and hybridization is also possible for above techniques.

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