Enhancement of Contrast And Resolution of Internal Noise Induced Dark Images By Combined DWT And DCT Domain Using Dynamic Stochastic Resonance Technique

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Abstract- *An image is suffered from low resolution, low contrast due to lack of sufficient illumination. This paper introduce a new concept of image resolution using discrete wavelet transform and contrast enhancement of dark images using dynamic stochastic resonance in discrete cosine transform domain. The first step in this method is decomposition of dark image into four frequency sub-bands using DWT. In second step block wise DCT is applied on low frequency sub-bands. In third step for each DCT sub-blocks DSR based enhancement technique is applied. The DSR-DCT technique adopts a local adaptive processing method which significantly enhances image contrast, color information while ascertaining good perceptual quality.*

Keywords- Resolution, Discrete Wavelet Transform, Discrete Cosine Transforms, Dynamic Stochastic Resonance, Contrast Enhancement.

I. INTRODUCTION

Many images have very low dynamic range of the intensity values due to insufficient illumination, and therefore need to be enhanced before being displayed to improve visual perception. Enhancement is widely used word in image processing. It is the process of improving the quality of the image by doing some manipulations. The target is to improve the perception of information contained in image foe viewers [1]. Lots of new mathematical tools are being added to the literature every day. Transform domain and spatial domain are considered to improve the resolution of satellite images. It is observed that transform domain methods produce better resolution as compared to spatial domain. There are different methods in transform domain. In this paper DWT is adopted. The main advantage of using DWT is multi resolution which provides good time resolution and poor frequency resolution at high frequencies and good frequency resolution and poor time resolution at low frequencies.

On the other hand, as Contrast Enhancement is a systemic operation in image processing which enhances human recognition of details secret in the scene and also renewed very rapid recognition of interested purposes. It makes various contents of images easily perceptible through suitable increase in contrast.

Usually noise is thought to be a nuisance which disturbs the system. But in this paper, noise is used to enhance rather than hinder the system performance. This phenomenon is called Stochastic resonance. The first experimental work on visualization of stochastic resonance was reported by [2]. Recently some of the works on application of stochastic resonance for grayscale image or edge enhancement that have been reported in literature are [3, 4, 5, 6, 7, 8, 9,10]. A dynamic stochastic resonance-based technique by scaling of DCT coefficients using bistable potential double well model is used here. The unique feature of this technique is use of internal noise instead of externally added noise and an adaptive local neighborhood processing.

II. PRELUDE

This section includes the brief mathematical introduction of DWT, DCT and DSR used in this paper.

A. <u>Discrete Wavelet Transform</u>

The main feature of wavelet transformation is to analyze the function at various level of resolution. It is a transformation that separates the data into two components: frequency and time. The multi-resolution characteristics of DWT provide good time resolution and poor frequency resolution at high frequencies and at low frequencies good frequency resolution and poor time resolution. Therefore, it is more suitable for short duration of higher frequency and longer duration of lower frequency components. This property enables it efficient to be used for image perspective. In image enhancement, the lower frequency components i.e., low intensity pixel values are analyzed more accurately. Let M×N is the size of input dark image I(x,y), then

$f(u,v)=\Sigma\Sigma 2^{j}\Phi(x-u,y-v)I(x,y)dxdy$-----(1)

where f(u,v) is the DWT transformed data in the frequency domain and Φ(x-u,y-v) is a scaling function.

B. Discrete Cosine Transform

The Discrete Cosine Transform converts the function into its elementary frequency components. During quantization of these elementary frequency components some irrelevant and less important frequency components are discarded. Therefore, the processed data become compressed retaining only useful information. Also, DCT coefficients are real, so become fast processing [11].Mathematically,

$F(p,q)=\{\sqrt{2}/M\sqrt{2}/N\sum\sum\lambda(u,v)\cos[\pi p(2u+1)/2N]\cos[\pi q(2v+1)2M]f(u,v)\}$ ----------------(2)

where $\lambda(i) = 1/\sqrt{2}$ for $\varepsilon = 0$

1 otherwise,

λ(u,v) is a weight coefficient and F(p,q) is the DCT transformed data in the frequency domain.

C. Dynamic Stochastic Resonance

Stochastic Resonance (SR) is a phenomenon in which noise is used to enhance the quality of the image. The mathematical description of SR is given in brief. According to the theory of Benzi, the transition of particle is analogous to the image pixel intensity variations. The equation of motion can be given as,

$$dx(t)/dt = -dU(x)/dx + \sqrt{D}\xi(t) \quad \text{-----------(3)}$$

This equation is given by Langevin in 1908, describing the time evolution of a subset of the degrees of freedom is friction under which a particle of mass m is moving within the well. Additive stochastic force is applied with the intensity D. U(x) is bi-stable potential function and can be described as:

$$U(x) = -ax^2/2 + bx^4/4 \quad \text{--------------(4)}$$

where a and b are positive bi-stable parameters, defined by $a = 2\sigma^2$ and $b<4a^3/27$. To make it time dependent term B sin(ωt) is added, where B is the amplitude and ω is the frequency of the signal respectively. The most common quantifier of stochastic resonance is signal-to-noise ratio (SNR) is given by [12]:

$$SNR = [4a/\sqrt{2}(\sigma_0\sigma_1)^2]\exp(a/2\sigma^2) \text{--------------(5)}$$

where σ_0 and σ_1 are the standard deviation of the original system and the resonance based system respectively. The particle's oscillation corresponds to the number of iterations. The Dynamic SR equation is:

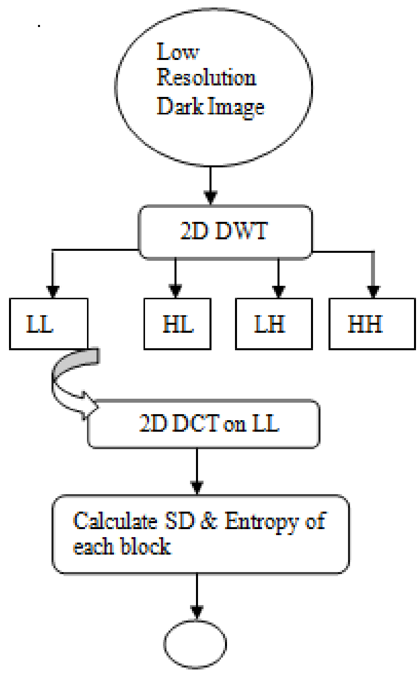
$$X(n+1) = X(n) + \Delta t[aX(n)- b^3X(n) + Input] \text{------- (6)}$$

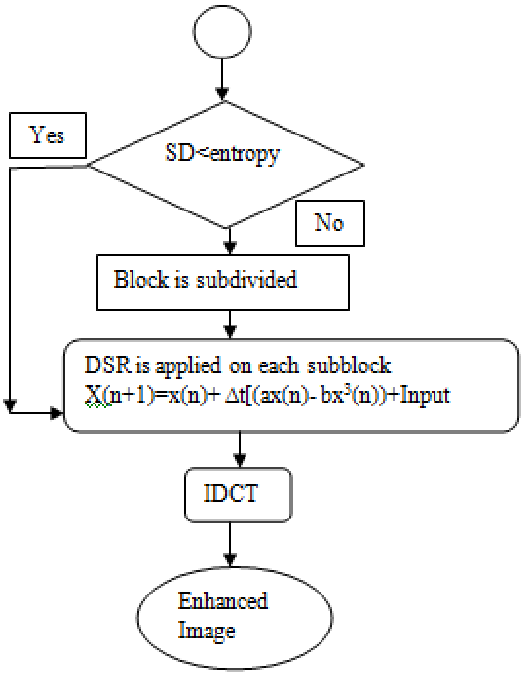
where the Input is defined by B sin(ωt)+√Dξ(t). The values of a and b are obtained by the maximization of SNR, as described in [13]. The detailed description of SR in the context of image processing is given in [12][13][2]. Using internal noise and maximization of signal-to-noise ratio (SNR), the brightness and contrast of the image enhances relatively. Therefore, the visual quality of the dark image gets enhanced.

III. PROPOSED METHOD

The proposed method performs resolution & contrast enhancement on colored images by applying Dynamic Stochastic Resonance (DSR) iteratively on the DCT coefficients.

A.Flow Chart:





B. Role of Combined Domain

Generally a transformation is a change in the numeric representation of a signal that preserves signal information. Transformations can be thought of as a change of coordinates into some coordinate system [11].Because of the wavelet's excellent spatial localization, frequency spread, and multi-resolution characteristics, these are widely being used in image processing field. Also, DCT transforms the image signal into its elementary frequency components, which implies lower computational complexity and sometimes important for real-time applications. It is known that the DC coefficients represent the average brightness of an image while the sum of squares of the normalized AC coefficients gives variance of an image. Thus, modification in DC coefficients of each block would increase the local brightness. This makes it very helpful for the enhancement perspective

C. Measure Parameters

- Color Enhancement Factor (F): The enhancement factor defined as ratio of colorfulness of output and input images respectively. The non-reference matric in terms of colors called as colorfulness matric (CM) is given as,

$$CM=\sqrt{(\sigma^2_\alpha+ \sigma^2_\beta)}+0.5\sqrt{(\mu^2_\alpha+\mu^2_\beta)}$$

  where α= R-G and β= (R+(G/2))-B. Similarly σ_α and σ_β are standard deviations and μ_σ and μ_β are means of α and β respectively.

- Contrast Enhancement Factor (CEF): It is the ratio of enhanced output and original image. Mathematically the parameter Q measures the structural variations present in the image, as

$$Q = \sigma^2/\mu$$

  where σ and μ is the standard deviation and mean of the image respectively.

- Perceptual Quality Measurement (PQM): This parameter is efficient in computational as well as in the context of memory utilization. Mathematically,

$$PQM = \alpha +\beta B^{\gamma1} A^{\gamma2} Z^{\gamma3}$$

  where, α, β and γ_s are estimated with subjective test data. B, A and Z are average blockiness, average absolute difference between in-block image and zero crossing rate respectively.

IV. CONCLUSION

This paper has analyzed resolution & contrast enhancement of very dark images using DWT-DSR-DCT based enhancement technique. The main advantage of resolution enhancement using DWT is it provides good frequency resolution & poor time resolution at low frequencies. A Dynamic Stochastic Resolution technique for contrast enhancement in DCT domain increases the variance of the DCT coefficients distribution leading to an increase in contrast. It adopts adaptive algorithm to give least iteration count. Due to adaptive sub-block selection, it enhances very dark as well as low-contrast images very efficiently while implicitly preserving and enhancing color information.

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