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Noise Reduction of Enhanced Images Using Dual Tree Complex Wavelet Transform and Shrinkage Filter

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ABSTRACT: The project presents that noise reduction of enhanced images using Dual tree complex wavelet transform and Bivariate shrinkage filter.Enhanced image gets affected during contrast enhancement process.So the denoising process will be handled to reduce distortion under Dual tree complex wavelet transform domain. Initially noisy image pixels are decorrelated to obtain coarser and finer components and more noise details are contaminated in high frequency subbands. In order to reduce the spatial distortion during filtering, bivariate shrinkage function used in the DTCWT domain.The effect of noise in the images can be reduced by using either spatial filtering or transform domain filtering. In transform domain wavelet method provide better de-noising while preserving the details of images like edges. In order to increase the quality of the super resolved image, preserving the edges is essential.The guided filter is not directly applicable for sparse inputs like strokes. It also shares a common limitation of other explicit filter,it may have halos near some edges.In order to overcome these disadvantages Dual Tree Complex Wavelet Transform (DT-CWT) is used which provide perfect reconstruction over the traditional wavelet transform.Experimental results show that the resultant algorithms produce images with better visual quality and at the same time performance can be improved.Evaluation is carried out in terms of various parameters such as Peak Signal to Noise Ratio, mean Structural Similarity and Coefficient of Correlation.

KEYWORDS: Noise reduction,Image Enhancement,DT-CWT,guided filter,shrinkage

I. INTRODUCTION

During transmission and reception images are usually affected by noise which cannot be easily eliminated in image processing applications. This appears owing to the real signals getting corrupted by unwanted signals. These noises occur as random black and white snow-like patterns on television screens. The purpose of the denoising algorithm is to remove such noise. Image denoising and image enhancement appears to be same. But both are entirely different processes. Image enhancement is an objective process, whereas image denoising is a subjective process. In image denoising by using prior knowledge of the degradation process attempts are made to recover the degraded image. Image enhancement does manipulation of the image characteristics to make it more appealing to the human eye. Image denoising techniques are broadly classified into spatial domain and transform domain techniques. The spatial domain techniques use simple spatial filters such as lee, kalman, foster, median, mean filters etc. In this technique data operation is carried out on the original image by processing the gray scale value.

In transformation domain techniques transformation is applied to the image and coefficients after transformation are processed. The most successfully exploited approach for the past few decades in image denoising is by using wavelet transform. It uses a set of damped oscillating functions known as wavelet basis. Wavelet transform is broadly classified into Continuous Wavelet Transform (CoWT) and Discrete Wavelet Transform (DWT). CoWT is powerful in singularity detection. A standard DWT is a discrete and fast implementation of Continuous Wavelet Transform with real valued basis. It can be implemented through a simple filter bank structure of recursive FIR filters. An important feature of DWT is its Multi resolution Analysis. It allows DWT to view and process different signals at various resolution levels. This feature popularized DWT to be used as an efficient tool in many image processing

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applications. Researchers have successfully applied DWT in many image compression and denoising applications. Another important feature of DWT is the ability of decorrelation i.e., separation of noise and useful signal. Even though DWT has attained its impression in many image processing applications it is hampered by two main disadvantages: poor directional selectivity and shift variance. The most straightforward way of distinguishing information from noise in the wavelet domain is by thresholding the wavelet coefficients. The method which removes the small coefficients while others are retained is known as Hard thresholding. In this process, certain blips known as Artifacts may occur which shows the unsuccessful attempts to remove moderately large noise coefficients.To cover the demerits of Hard thresholding, wavelet transform Soft thresholding was introduced.[1]

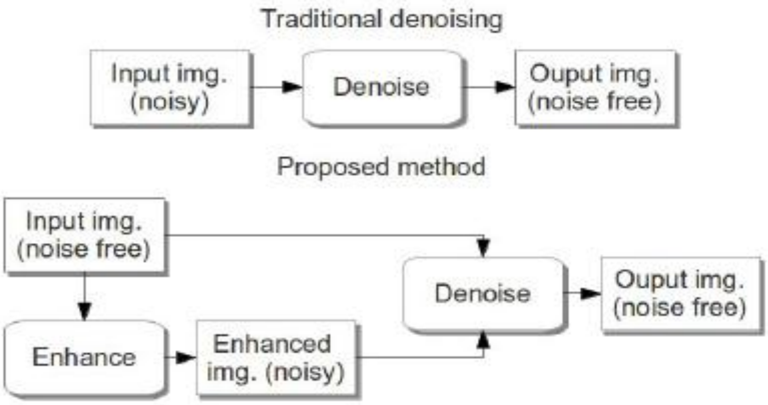

Fig.1.1 Flow charts for traditional noise-reduction methods and the proposed one.

A. Image Enhancement:

Image enhancement improves the quality (clarity) of images for human viewing. It basically improves the interpretability or perception of information in images for human viewers and providing `better' input for other automated image processing techniques. The principal objective of image enhancement is to modify attributes of an image to make it more suitable for a given task and a specific observer.

Removing blurring and noise, increasing contrast, and revealing details are examples of enhancement operations. Reducing the noise and blurring and increasing the contrast range could enhance the image.
The image enhancement methods can broadly be divided in to the following two categories:[2]
1. Spatial Domain Methods
2. Frequency Domain Methods

II. RELATED WORK

[3]Authors introduced the concept of bilateral filtering for edge-preserving smoothing.Edge transitions are often too abrupt after filtering, so it results in a cartoon-like appearance of the filtered images.Due to unwanted effects, we limit the edge sharpening by imposing a minimum smoothing in the filter.[4]Based on bilateral, joint bilateral filter is formed and the up sampling problem gets reduced.To adopts real time implementation using histogram-based joint bilateral filtering.By using this computation efficiency is high.But it may have artifacts in detail decomposition and HDR compression.Gradient reversal-Introduction of false edges in the image.Another issue concerning the bilateral filter is its efficiency.[5]Guided image filter is used to filter out the noise under the guidance of the original image. The guided filter is an edge-preserving smoothing filter like the bilateral filter, it avoids the gradient reversal artifacts that may appear in detail enhancement and HDR compression.But it may have halos near some edges. In fact, it is ambiguous for a low level and local operator to determine which edge should be smoothed and which should be preserved. Unsuitably smoothing an edge will result in halos near it.

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III PROPOSED SYSTEM

The project presents that noise reduction of enhanced images using Dual tree complex wavelet transform and Bivariate shrinkage filter.Enhanced image gets affected during contrast enhancement process. So the denoising process will be handled to reduce distortion under Dual tree complex wavelet transform domain. Initially noisy image pixels are decorrelated to obtain coarser and finer components and more noise details are contaminated in high frequency subbands.In order to reduce the spatial distortion during filtering, bivariate shrinkage function used in the DTCWT domain.An Image quality will be preserved because of gathering details about edges and texture at different orientations.The performance of proposed method is measured by nuisance parameters such as RMSE, PSNR.

Noise suppression is an integral part of any image processing task. Noise significantly degrades the image quality and hence makes it difficult for the observer to discriminate fine detail of the images especially in diagnostic examinations.Through decades of research, mass articles on image denoising have been proposed. The effect of noise in the images can be reduced by using either spatial filtering or transform domain filtering.In transform domain wavelet method provide better denoising while preserving the details of images like edges. The Discrete Wavelet Transform (DWT) has some disadvantages that undetermined its application in image processing as lack of shift invariance and poor directional selectivity.In order to overcome these disadvantages Dual Tree Complex Wavelet Transform (DT-CWT) is used which provide perfect reconstruction over the traditional wavelet transform.

A Dual Tree Complex Wavelet transform based image denoising is proposed which uses generalized cross validation technique. The denoising performance for different images using Discrete Wavelet Transform and Dual Tree Complex wavelet transform with different thresholding need to be evaluated. Evaluation is carried out in terms of various parameters such as Peak Signal to Noise Ratio, mean Structural Similarity and Coefficient of Correlation.

A. Dual Tree Complex Wavelet Transform:

Dual Tree Complex Wavelet Transform (DTCWT), a form of discrete wavelet transform which generates complex coefficients by using a dual tree of wavelet filters to obtain their real and imaginary parts. The dual tree implementation of a complex wavelet transform (DTCWT)have the desirable properties of approximate shift invariance and good directional selectivity.These properties are important for many applications in image analysis and synthesis, including denoising, deblurring, super resolution, watermarking, segmentation and classification.

The key to obtain shift invariance from the dual tree structure lies in designing the filter delays at each stage, such that the low pass filter outputs in tree b are sampled at points midway between the sampling points of the equivalent filters in tree a. This requires a delay difference between the a and b low pass filters of 1 sample period at tree level 1, and ½ sample period at subsequent levels. At levels 1 any standard orthogonal or bi-orthogonal wavelet filters are used and produce the required delay shift trivially by insertion or deletion of unit delays, but at further levels the ½ sample delay difference is more difficult. In order to give the dual-tree improved orthogonality and symmetry propertied over the earlier form, Q-shift filters for level 2 and below are introduced. The DTCWT for 2-D image is obtained by separate filtering along rows and then columns.

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B. Bivariate Shrinkage Function Estimation:

With good properties of multi-resolution, localization, anisotropy and directionality, quaternion wavelet transform could represent edges and singularities more efficiently. Quaternion wavelet coefficients exhibit strong non-Gaussian statistics. So there are strong dependencies between a quaternion wavelet coefficients and its parent. In this section, we use bivariate model to characterize the dependency between a quaternion coefficient and its parent.The corresponding bivariate maximum a posterior (MAP) estimator based on noisy quaternion wavelet coefficients.The basic Bayesian estimation method is modified via considering the dependency between quaternion wavelet coefficients and its parent.

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C. Proposed System Block Diagram:

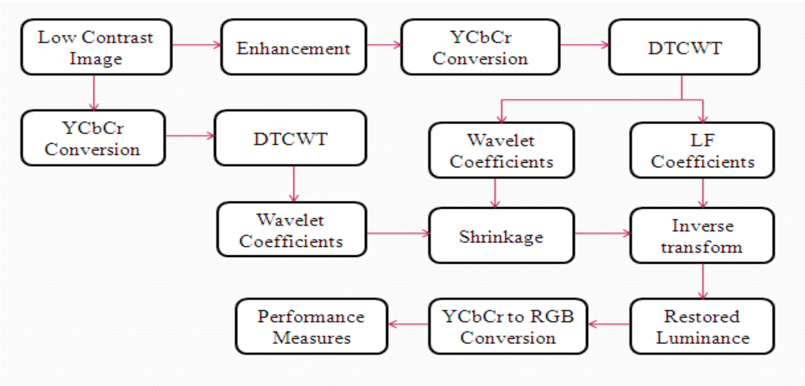

Fig.3.1 Proposed System Block Diagram

D. Preprocessing:

An input low contrast image is enhanced using histogram equalization technique to improve clarity of an image.Due to this process, an image information degrades causes spatial distortion which appears like a noises.To improve the smoothing details contains structural component and also prevents textural details, luma plane of enhanced image will be processing using complex wavelet shrinkage.The luminance or luma component of image will be separated using image processing commands ‘rgb2ycbcr’.

E. DTCWT decomposition:

An input noisy image will be decomposed into components like textural and structural details using dual tree complex wavelet transform.It is a shift and rotation invariant transform describes the textures and edges in various directions.DT-CWT decomposes an image into low and high frequency subbands. Low/high frequency subbands are contains coarsest and finest details.It is directionally selective in two and higher dimensions where the high-frequency sub bands in six different directions contribute to the sharpness of the image details.The real and complex band coefficients are utilized to modify by shrinkage method and LF’s are kept same.

F. Transform domain filtering:

Under transformed domain, shrinkage rule is used here to restore coefficients from high frequency bands.The high frequency subbands are highly contaminated by random noise which affects edges and texture of image.It will be removed by shrinkage approach i.e., Bivariate shrink which shrinks the complex wavelet coefficients above the threshold and discards below the threshold.The threshold will be estimated through robust median estimator and signal variance.The coarsest details will be kept same and finest details are applied for shrink process to suppress the noises.Finally restored components will be reconstructed with inverse DTCWT to obtain resultant images.

G. Threshold Estimation:

The threshold will be selected for shrinking complex wavelet subband coefficients to remove the noise.The bivariate threshold will be determined by,

$$T = \text{sqrt}(3)*N_{var}^{2} / S_{var}$$

Where,

N_{var} - Noise variance estimated by robust median estimator.

$$N_{var} = \text{median}(\text{abs}(C))./0.6745$$

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S_{var} - Signal Variance estimated by,

$$S_{var} = \text{sqrt}(\text{Wcoef} - N_{var}^2)$$

and approximated coefficient: Wcoef = conv2(C^2,Fcoef) C - Wavelet Coefficients and Fcoef – Filter coefficients

H. Performance Calculation:

PSNR (Peak Signal to Noise Ratio)

$$\text{PSNR}=10log_{10}\frac{255}{MSE}^{2}$$

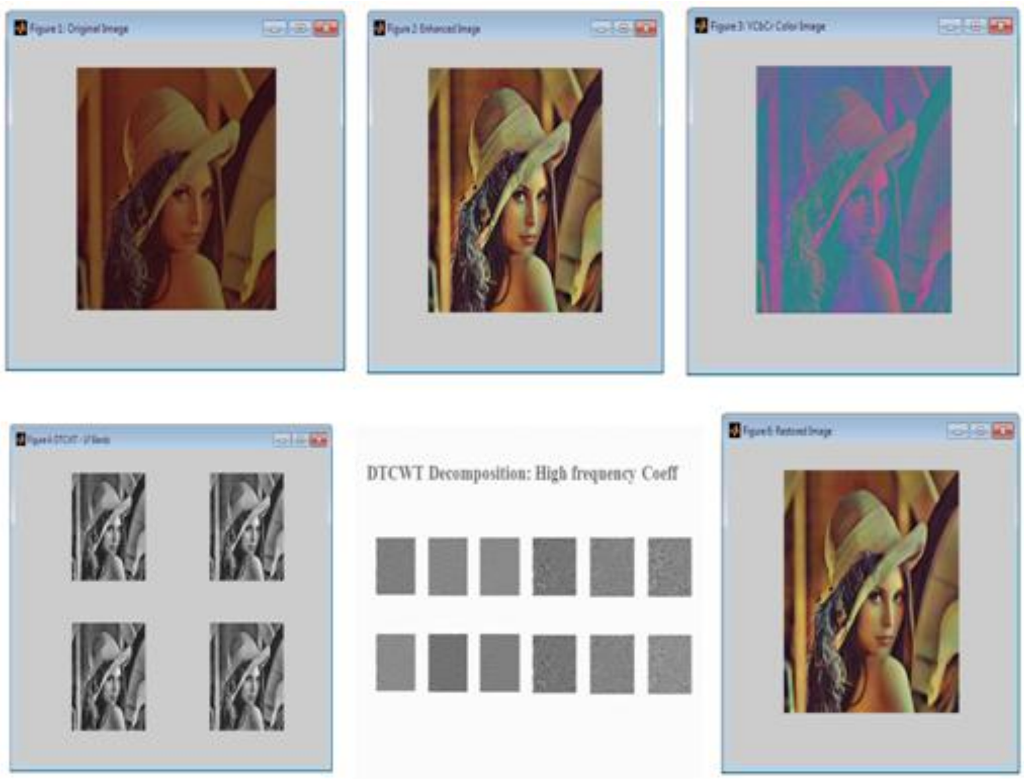
MSE (Mean Square Error)

$$\text{MSE}=\frac{1}{M\times N}\sum_{i-1}^{M}\sum_{j-1}^{N}(a_{y-b_y})^2$$

Where,
M,N are Number of Rows and Columns
a_{ij} – Input Image and b_{ij} –Enhanced Image

PSNR values of the proposed technique are substantially higher than those of the conventional DWT at less computational complexity and achieves better denoising performance.

IV EXPERIMENTAL RESULTS



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*****Performance Measures*****
Correlation Coefficient:
    0.9195

Standard Deviation:
    7.3609

Root Mean Square Error:
    0.5646

Percentage Residual Difference:
    0.0088

Peak Signal to Noise Ratio:
   50.6136

>> |
```

Fig.4.1 Shows Experimental Results

V.CONCLUSION

The existing Guided filter may have halos near some edges,also it has low performance.To overcome this drawback Contrast enhancement technique based on DT-CWT has been proposed.This technique decomposes the LR input image using DTCWT.By using the Lanczos interpolator Wavelet coefficients and the LR input image was interpolated.Further enhance the performance of the proposed technique in terms of RMSE, PSNR.PSNR values of the proposed technique are substantially higher than those of the conventional DWT at less computational complexity and achieves better denoising performance.

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BIOGRAPHY

S. Arulmozhi has completed her graduation in B.E Electronics and Communication Engineering in the year 2013 at Pallavan college of engineering,Kanchipuram affiliated to Anna University, Chennai, India and presently doing her post graduation in M.E Applied Electronics in the year 2013-15 at Kingston Engineering College, Vellore. She is working towards her research in the field of smoothing and enhancement. Her area of Specialization includes Image processing.