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A New DWT and Median Filter Based Noise Removal Method for Images

Sunita Janoriya, Prof. M P. Parsai,
Department of Electronics &Telecommunication Engineering,
Jabalpur Engineering College
Jabalpur, Pin-482011
Madhya Pradesh – India

ABSTRACT

DWT cum median filter is proposed for the restoration of images that are highly corrupted by white noise or salt & pepper noise. In this filter at first the noisy pixel is identified and then it is replaced by a suitable value. Here the size of the DWT window automatically increases until it gets its suitable median value to replace the noisy pixel. This proposed algorithm shows better results than the switching mean median filter (SMMF). The proposed algorithm is tested against different images and it gives better Peak Signal-to- Noise Ratio (PSNR), Mean Square Error (MSE) and Structural Similarity Index (SSIM).The work is been done with the help of MATLAB 2010 and the results of proposed filter is found better then available work.

Keywords:- DWT: Discrete Wave Transform, SVD: Singular Value Decomposition, LL: approximate band, LH: Vertical Band, HL: Horizontal band HH: diagonal detail band

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I. INTRODUCTION

Taking clear images noisy is tough; mostly due to haze mainly due to Colour scatter also addition to Colour cast by varying light attenuation on various wavelengths [2]. Colour scatter and Colour results a blurred subjects and with lowered contrast in all noisy images. In Figure 1, shows a example, Colour haze due to scattering of pixels.

Figure1: Haze in Noisy Images due to Blurry Effects on pixels

Figure2: salt and paper noise due to white noise

Salt and paper noise is because by many suspended particles when camera capture images reflected light from objects goes to camera, it is mainly happens in rainy season, underwater, very hot deserts, and satellite images, few portion for light meets suspended particles, which absorbs few for light and scatters light. In environments which do not have blackbody emission [3], scattering normally expands to multiple scattering.

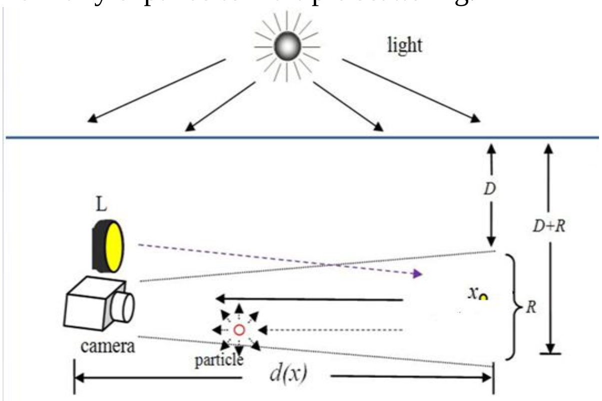

Figure3 Natural Light Illuminates an Noisy target point x and Reflected Light goes to Camera by Direct Transmission with Scattering

II. DESIGN METHODOLOGY

Thesis work present a novel procedure for which is a special integration for various available techniques also it has new approach for adaptive image filtering with histogram base image stretching as pre-processing and DWT cum median filter is proposed for the restoration of images that are highly corrupted by white noise or salt & pepper noise. In this filter at first the noisy pixel is identified and then it is replaced by a suitable value. Here the size of the DWT window automatically increases until it gets its suitable median value to replace the noisy pixel. This proposed algorithm shows better results than the switching mean median filter (SMMF), proposed work is also preserving the edges of image.

Proposed work is new design for filtering noise in images it includes infrared images also, the work begin with histogram analysis of the image and based on histogram analysis image stretching performed which enhance the colour in the image, the histogram analysis and image stretching can be consider as pre-processing of the work, after pre-processing canny edge detection of the image is been performed hence the edges can be preserve in filtering then DWT transform is been performed for frequency isolation of the image, frequencies which appears out of the range and can be separated, at the last adaptive DWT based median filter remove all the undesired components form the image.

Algorithm

Step 1: Histogram of the given image, by employing a histogram for digital values in order to an image and redistributing stretching value over image variation for maximum range for possible values [14]. Furthermore linear stretching from 'S' value may provide stronger values to each range by looking at less output values. Here a percentage for saturating image may be controlled in order to perform better visual displays.

Consider 'a' is a discrete and let n_i be the number of occurrences of gray level i. The probability of an occurrence of a pixel of level i in the image is

$$P_a(i) = p(a == i) = \frac{n_i}{n}, \quad 0 \le i \le L$$

L being the total number of gray levels in the image (typically 256), n being the total number of pixels in the image, and $P_a(i)P_a(i)$being in fact the image's histogram for pixel value i, normalized to [0,1].

Step 2: The contrast/colour stretching algorithm is used to enhance contrast for image. This is carried out by stretching range for colour values to make use for all possible values using the information provided by histogram analysis. Contrast/ colour stretching procedure use linear scaling function in order to pixel values. Every pixel is scaled using following function below:-

$a_o = \{(a_i\text{-}c) \times (b\text{-}c) / (d\text{-}c)\} + a$

Where

a_o is normalized pixel value;

a_i is considered pixel value taken

a is minimum value for desire range;

b is maximum value for desired range

c is lowest pixel value present in image;

d is highest pixel value present in image

The values of a, b, c and d computed from histogram values $P_a(i)$

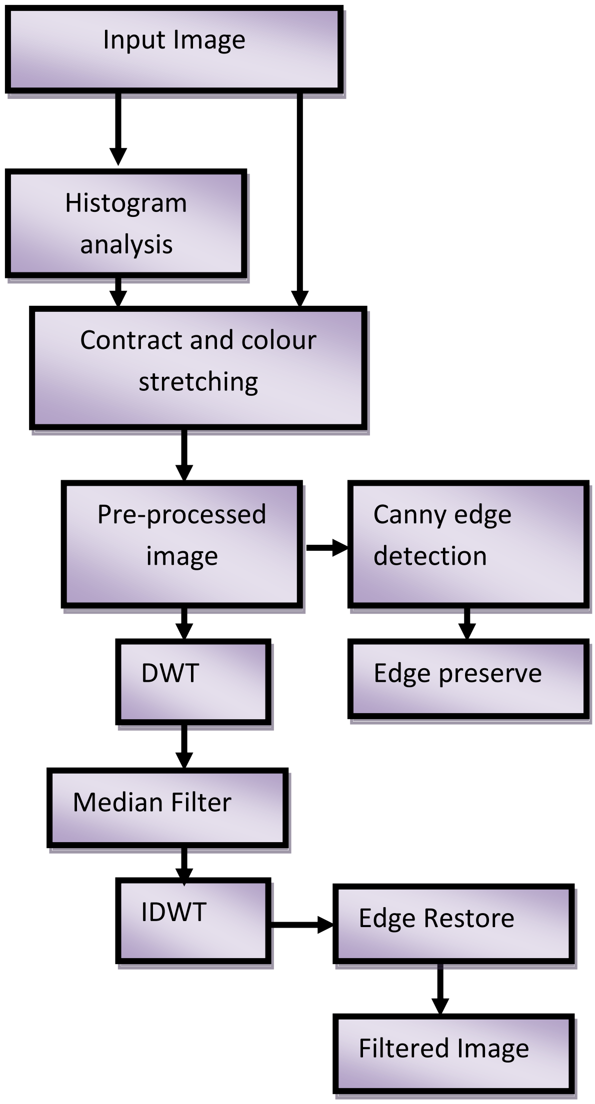

Figure 4: flow and block diagram of the work

Step 3: The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images. An edge in an image may point in a variety of directions, so the Canny algorithm uses four filters to detect horizontal, vertical and diagonal edges in the blurred image. The edge detection operator (such as Roberts, Prewitt, or Sobel) returns a value for the first derivative in the horizontal direction (G_x) and the vertical direction (G_y). From this the edge gradient and direction can be determined:

$$G = \sqrt{a_x^2 + a_y^2}$$

$$\emptyset = \arctan2(a_x, a_y)$$

where G can be computed using the hypot function and atan2 is the arctangent function with two arguments. The edge direction angle is rounded to one of four angles representing vertical, horizontal and the two diagonals (0°, 45°, 90° and 135°). An edge direction falling in each colour region will be set to a specific angle values, for instance θ in [0°, 22.5°] or [157.5°, 180°] maps to 0°. The edges (G, Ø) will be preserve and at the time of image reconstruction it will be used and all the preserve pixels will replace the obtain pixels.

Step 4: 'a' is the image obtain after pre-processing (histogram and contrast stretching), DWT applied on 'a', Proposed work use 'sym4' type wavelet for decomposition of image

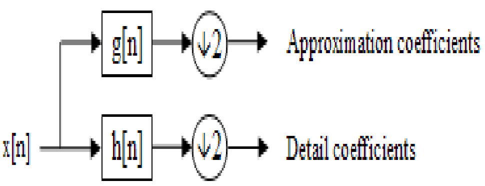

Figure 4 DWT HP and LP coefficient generation

DWT decomposing is require because after DWT decomposing, frequencies of image separates and with the help of that frequencies we can separate the LL, LH , HL and HH component and in proposed method different frequencies will be filtered differently.

Step 5: DWT based Median filter , The median filter is a nonlinear digital filtering technique, often used to remove noise from an image, The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal. For 1D signals, the most obvious window is just the first few preceding and following entries, whereas for 2D (or higher-dimensional) signals such as images, more complex window patterns are possible (such as "box" or "cross" patterns).

To demonstrate, a window size of three with one entry immediately preceding and following each entry, a median filter will be applied to the following simple 1D signal:

x = [2 80 6 3]

So, the median filtered output signal y will be:

y[1] = Median[2 2 80] = 2

y[2] = Median[2 80 6] = Median[2 6 80] = 6

y[3] = Median[80 6 3] = Median[3 6 80] = 6

y[4] = Median[6 3 3] = Median[3 3 6] = 3

i.e. y = [2 6 6 3].

Step 6: IDWT taken for the filtered image elements HH, HL, LH and LL

Step 7: Replace the preserve pixels of after canny edge detector. Final constructed image is filtered image

III. RESULT

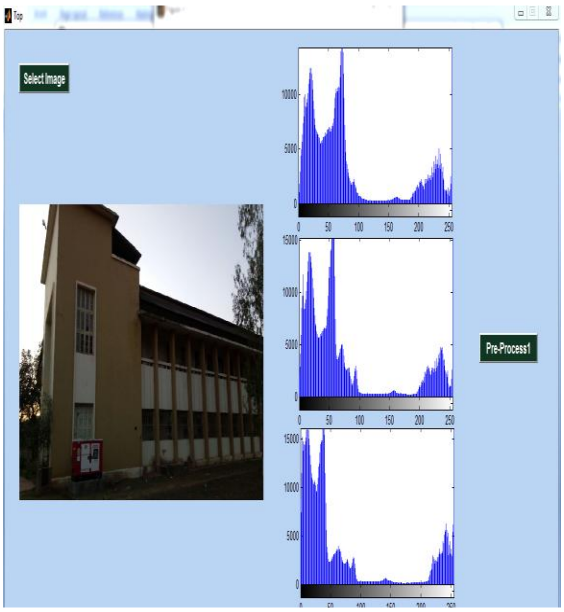

Figure 5 the input image and its histogram

Figure 6 contrast stretching based on histogram

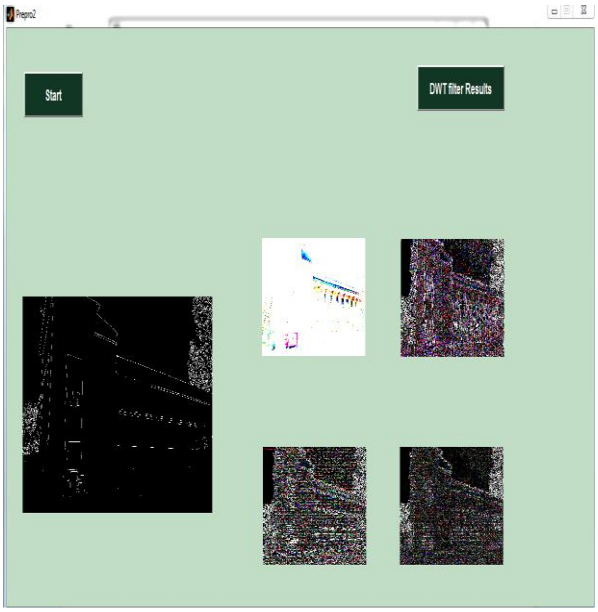

Figure 7 DWT decomposition and Canny edge detection

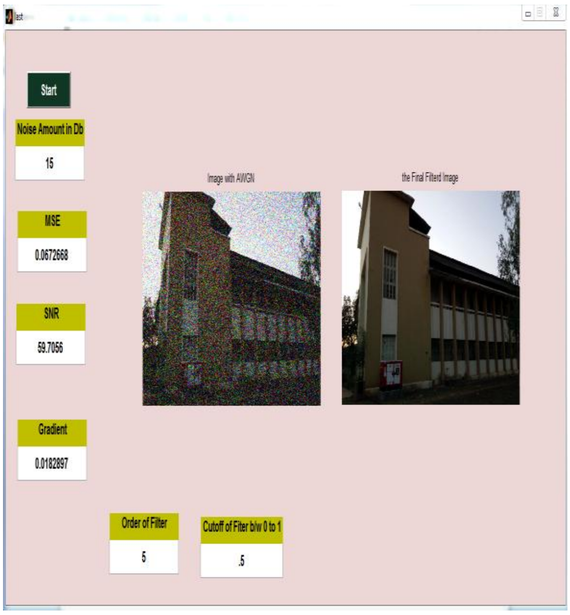

Figure 8 noisy image and filtered after adaptive filter

Figure 5, 6, 7 and 8 are the GUI developed for better interfacing, the SNR obtain for the 256x256 infrared image is 56.26, MSE observe is 0.1.

IV. CONCLUSION

The work done in area for noisy image enhancement till now either using median or Adaptive filters or by using various colour stretching methods or by using equalizing, however no one has presented a modal which is integrated for various technique, Thesis work present a novel procedure for which is a special integration for various available techniques also it has approach for histogram based image stretching and DWT based Median filtering Proposed approach has produced good results. Quality for images is statistically observed through histograms. Future work will include further evaluation for proposed approach. It may be clearly seen that proposed procedure is best among available procedure with very high PSNR means significantly remove noise and very less MSE hence it has very low error.

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