An Approach to Image Enhancement using Discrete Wavelet Transform

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Abstract— Image enhancement helps in bettering the visibility of any part or feature of the image by improving the information in visual parts or features. Several techniques offer contrast regulation as a way which proves to be a cogent tool to improve the quality of an image. So image enhancement by applying various algorithms and techniques make an image individually looks better than the original image. This research work presents a novel DWT based image enhancement technique. The approach presented in this work is simple and robust and can be used to improve the perceptual visual quality of low resolution images. The images used in implementation are standard test images of 256x256 pixel values but of low visual perceptibility. The power log transformation evaluates the threshold value from the frequency (wavelet) transformed coefficients of the input image. This threshold values is used to transform the decomposition vector obtained from the 2-d multilevel wavelet decomposition. This modified vector is then reconstructed to obtain the enhanced image pixels. At last histogram equalization method is applied to improve the visual appearance of the image. The performance the algorithm has been evaluated using a Mean Square Error and Peak Signal to noise measures. The PSNR value is close to 40 db for almost all images which shows a good improvement over previous methods.

Key words: Image Enhancement, Contrast, Multiresolution Wavelet, Histogram Equalization

I. INTRODUCTION

Enhancement of an image is vital to improve the image appearance or to highlight some condition of the image is converted from one into another collected, scanned, transmitted, copied or printed various types of noise can be present in an image. An Image enhancement has come to especially mean a procedure of smothering irregularities or noises that has somehow distorted the image and its quality. The term "image enhancement" has been largely utilized in the past to define any operation that improves or enhances the image quality by using some criteria. However, in the recent times the meaning of the term has derived to denote an image-preserving noise smoothing. An Image enhancement is an essential tool for researchers in a wide range of areas. In forensics, an image enhancement is utilized for identification, collecting evidence and surveillance. For example, images found from the fingerprint detection, security videos scrutiny and crime scene investigations are improved to help in identification of culprits and security of victims. In atmospheric sciences image enhancement is utilized to minimize the effects of haze, mist and turbulent weather for the meteorological observations. It is helpful in detecting the shape and structure of the remote objects in an environment sensing. Astrophotography shows challenges due to light and noise pollution that can be minimized by image enhancement. For real time sharpening and contrast improvement several cameras have built-in image enhancement functions.[1] [3] [5].

II. LITERATURE REVIEW

Resolution has been frequently referred as an important aspect of an image. Images are being processed in order to obtain more enhanced resolution.[6] Image resolution enhancement techniques can be classified into two major classes according to the domain they are applied in:

1) Image-Domain;
2) Transform-Domain.

In spatial domain techniques, we directly deal with the pixels of a given image. The values of the pixels are utilized to achieve required enhancements. In frequency domain techniques, firstly the image is changed into the frequency domain. To perform this, the Fourier Transform of an image is find out first. An enhancement operations are done on this Fourier transform of an image and then to obtain the resultant image inverse Fourier transform is performed. These enhancement operations can be achieved to change many aspects such as, image contrast, brightness, or the distribution of the grey levels. As a output the pixel value of the resultant image gets changed according to the transformation functions that are used on the input values [7]. The processes used in image-domain utilizes the statistical and geometric data directly derived from an input image itself, while transform-domain schemes utilizes transformations to accomplish the image resolution enhancement.[8] There are many conventional image resolution enhancement techniques like nearest neighbor, linear, quadratic and cubic interpolation functions. But these techniques suffer from issues like blurring of edges, ringing around edges and loss of the texture [10] this is because they do not use any information related to edges in the original image. An Image resolution enhancement is one of the most common techniques of low-level digital image processing. A Digital image processing field explains the treatment of a digital images by means of a digital computer. An operation of low-level enhancement has both its inputs and outputs as images. The Low-level processes involve basic operations such as noise reduction, image sharpening and contrast enhancement. The main objective of image enhancement is to give a more appealing image, with easier differentiation of an objects, and improved clarity of object features and surface details.

A number of researchers have suggested methods of image resolution enhancement. According to Robert G. Keys [9] Cubic convolution interpolation is derived from set of conditions which are applied on interpolation kernel. Interpolation kernels are design to maximize accuracy for given level of computation factor. In terms of storage and computing time cubic convolution is more effective than cubic splines.

The work done by various scientists and researchers have been discussed as M. Knee et al 2015[11] , proposed an

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inversion technique which takes the negative of an image i.e. image inversion in which black pixels are mapped to white pixels and white to black pixels but the results were not satisfactory. Moreover, MSE is very high and PSNR is low. Hence, there was a need of a better technique.

Min goo boon et al 2009[12], has used a sharp filter to achieve image enhancement. The method was successful enough to get low MSE and high PSNR value but side regions were not clearly visible. This encouraged further research.

S. Asadi et al 2011[13], proposed a gamma correction technique in which image is divided into overlapping window and gamma value is estimated. This method was quite good to increase the brightness of the image but both MSE and PSNR value were not good as former being very high and latter being very low. So, this was also not optimum hence need for much better technique was felt.

Bhattacharya et al 2014[14], devised that contrast enhancement plays a pivotal role in this field but global enhancement lead to loss of information that's why a technique was introduced to carry out localized image enhancement named as singular value decomposition, SVD.

H. Hassan et al 2011 [15], has also used gamma adjustment technique and obtained satisfactory results in terms of MSE and PSNR values but again fail to achieve clear visibility of side regions.

Mohammed F.K[16] et al 2012, has proposed multi-histogram and by-histogram method in which one was preserving brightness at the cost of deteriorating natural display and the other was preserving natural display but was not able to maintain the intensity or contrast. So, input image was divided into different sectors thus reducing the decomposition error of input histogram.

Turgay Celik and Huseyin Kusetogullari[8] The DCWT scheme is utilized to decompose the original input image into various sub-band images. Using LR image, an initial approximation to unknown HR image is reconstructed using zero padding of high frequency sub-bands followed by ICWT. Deformations to initial estimation are used applying edge preserving smoothing filtering (EPSF).The image segmentation is a challenging problem that has received an enormous amount of attention by many researchers [1, 2, 3, 4]. Pham et al. and James et al. have presented various techniques used in medical image segmentation and analysis [5, 6]. The segmentation problem can be categorized as supervised and unsupervised problem. For appropriate analysis, different image models have been proposed for taking care of spatial intrinsic characteristics. The popular stochastic model, provides the better framework for many complex problem in image segmentation is Markov Random Field (MRF) model [7, 10]. MRF model and its variants have been successfully used for brain MR image segmentation [12, 13].

III. System Implementation

In this research work, the usage of Discrete Wavelet Transform for the purpose of Image Enhancement has been envisaged. The algorithm used here uses discrete Wavelet Transform technique to convert the original image i.e. the input image from spatial domain to transform domain

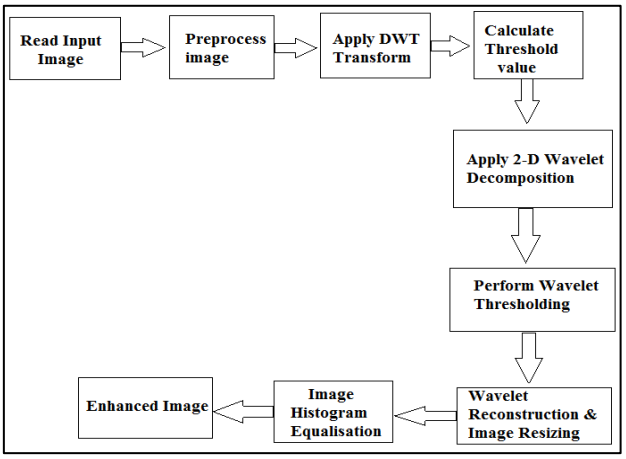

Fig. 1: Block Diagram of Proposed Image Enhancement Technique

The above diagram in figure 1, shows the block diagram of the proposed DWT based image enhanced technique. The various steps are explained as below:

– Algorithm

1) Read input image: The input image used here is standard test image of 256x256 resolution. The image is read as matrix.
2) Pre-process Image: Preprocessing is used to convert image in the desired system input format. The preprocessing includes image resizing and converting to grayscale format.
3) Apply DWT transform: DWT transform is performed on the image after choosing the desired wavelet filter.
4) Calculate noise threshold: The threshold value is calculated by estimating the noise thresholding value.
5) Apply 2-D wavelet decomposition: 2-d Wavelet decomposition is performed to obtain the image as decomposed vector.
6) Wavelet Thresholding: Wavelet thresholding is applied to estimate the values which needs to be enhanced.
7) Perform Wavelet Reconstruction and Resizing: Wavelet Reconstruction and resizing is performed.
8) Image histogram equalization: To enhance the quality of obtained image.

IV. Result & Discussion

The images as explained in can exist in various formats such as .jpg, .bmp., .png etc. The Discrete Wavelet transform technique will be used to transform these image from their original spatial domain to frequency domain. The multiresolution wavelet transform decomposes the image in its frequency domains into several coefficients. These coefficients are known as approximation coefficient, horizontal coefficients, vertical coefficients and diagonal coefficients. These contain details of the frequency variation of the image. The decomposition coefficient have been used to calculate the noise level of the power log transformation. Extensive experiments have been performed on a number of images to analyze the working of the algorithm. Several standard test images such as boat, baboon, Lena, peppers, couple, cameramen etc. are referred for image resolution enhancement. The images taken are of low contrast. They all are gray scale images with size 256x256. The obtained results

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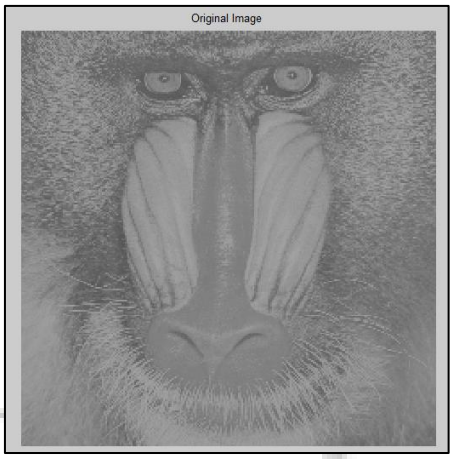
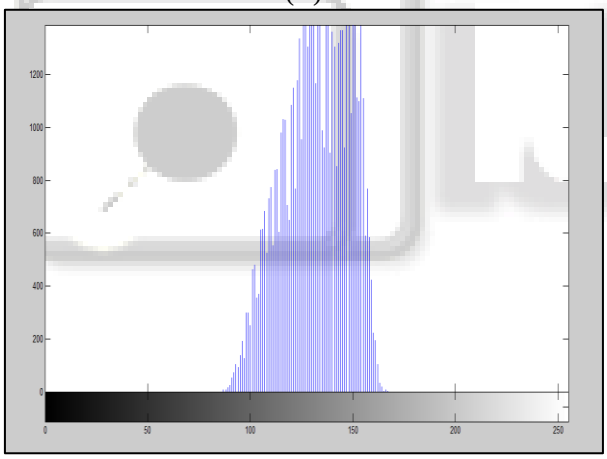
show the efficiency of the proposed technique as the visual perceptibility of the images is considerably improved as compared to original image. The analytical performance parameters are calculated in terms of MSE and PSNR values and the results show better results as compared to the previous research works in the same domain.

Figure 2a) shows the original input image of baboon.png. Figure 2 b) shows the histogram plot of the original image. The histogram plot gives an estimation of the variation of pixel values across all the pixels in the image. Figure 3 a) shows the wavelet decomposition of the original image.

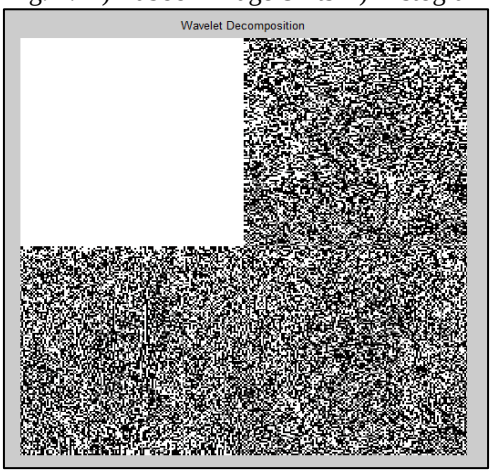


(A)

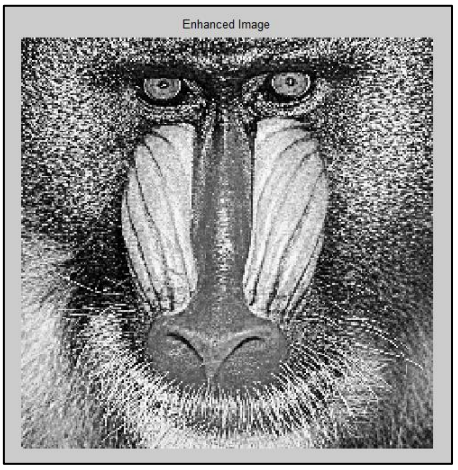


(B)

Fig. 2: A) Baboon Image & Its B) Histogram



(A)



(B)

Fig. 3: A) Wavelet Decomposition B) Enhanced Image

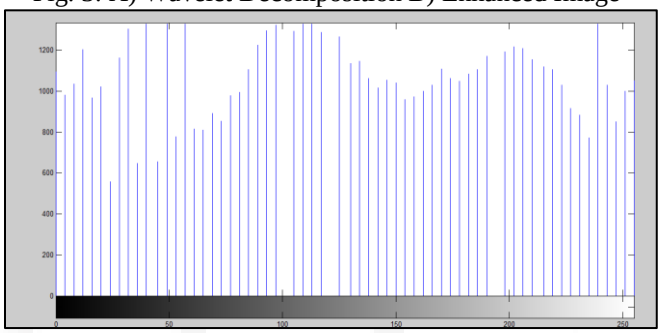


Fig. 4: Histogram of Enhanced Image

Figure 4 shows the histogram of enhanced image. As can be seen the histogram is more evenly distributed, which gives better visual perceptibility by improving and balancing pixel value.

Similar experiments were carried on other standard images i.e. Barbara, peppers, lena and boat all of dimensions 256x256. The results in terms of MSE and PSNR are summarized as below:

Image	MSE	PSNR
BABOON	1.1968e+03	39.9513
BARBARA	1.1498e+03	40.3520
PEPPERS	1.1788e+03	40.1025
LENA	1.2047e+03	39.8858
BOAT	1.3104e+03	39.0442

Table 1: Performance in terms of MSE and PSNR

V. CONCLUSION

Image enhancement using DWT transform has been performed and algorithm has been tested on several test images. A number of work done by previous research work is thoroughly studied and the important findings of those research work is presented in the Literature review section. The various terms and methodologies related to the image enhancement domain have been studied and summarized in this work. The power log transformation evaluates the threshold value from the frequency (wavelet) transformed coefficients of the input image. This threshold values is used to transform the decomposition vector obtained from the 2-D wavelet decomposition. This modified vector is then reconstructed to obtain the enhanced image pixels. At last

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histogram equalization method is applied to improve the visual appearance of the image. The performance characteristics evaluated in terms of Mean Square Error and Peak Signal to noise measures. The PSNR value is close to 40 db for almost all images which shows a good improvement over previous methods.

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