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Improved LWT SWT Resolution Enhancement Technique by Switching Interpolation Technique

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Abstract: The generation of the image processing has enormous fields and areas of applications. In this new world of technology it is playing its role efficiently. From health care to the space program, from transportation to the investigations, from entertainment to the information technology etc. "Digital Image Processing" also known as DIP has a major role to make things modern and easy at the same time. In this work it is focused on the enhancement of the digital image in the context of pixels. This enhancement is on the key feature of an image and known as resolution of an image. Resolution of an image is basically the grid size of pixels in an image. There is always a need of enhancing the resolution by other methods such as by external software or program. These resolution enhancement programs are different than zooming program in a way that they just not stretched it but interpolate in which means they generate pixels related to the other pixels of image virtually.

Keywords: LWT Lifting Wavelet Transform, SWT Stationary Wavelet Transform, PSNR Peak signal to noise ratio, MSE Mean square error, SNR Signal to Noise Ratio, RMSE Root Mean Square Error, MAE Mean Arithmetic error.

I. INTRODUCTION

In the recent years there is increment in the demand for better quality images in the various applications such as astronomy, medical, object recognition.

Irrespective of the equipment used, the raw images i.e. the image produced by such devices have to be processed so that the appearance of the image has to be converted in such form which is better suited for image analysis and understanding the minute details of the image. [1]

The techniques which are used for the purpose to improve the quality of the image are often termed as 'Image Enhancement Techniques' and are widely used in research field. These techniques aid in the improvement of an image appearance by enhancing image features in various region of the image. [2]

Image enhancement can be done in various domains. For image resolution enhancement there are many methods, such as image resolution enhancement by using DWT and SWT [3].

A number of images processing algorithms can be implemented with Discrete Wavelet Transform (DWT). Another out of which, image interpolation scheme is one of the most effective methods. Interpolation has been extensively used for resolution improvement [4].

However, resolution is vital aspect of any image. Good quality image i.e. high resolution image produces better result in image processing applications.

An interpolation is the technique to increase the resolution of the image by selecting new pixel from surrounding one.

II. APPLICATION AREAS OF HIGH RESOLUTION IMAGE

Following are such areas of applications:
Remote sensing [5]: an improved resolution image can be required in the numerous images of the same area are on condition.

Surveillance video [6]: the zoom and frame freezing or focus region of interest also known as (roi) in video for human insight. The resolution enhancement for automatic target acknowledgment (example try to recognize a criminal's face).the video standard conversion, example from ntsc video to hdtv signal.

Medical imaging [7]: x-ray-based devices, computed tomography (ct), magnetic resonance imaging (mri), ultrasound (us), positron emission tomography (pet) and single photon emission computed tomography (spect).

III.RELATED WORK

F. Malgouyres and F. Guichard focused on some reconstruction/restoration methods which aim is to improve the resolution of digital images. We study variation nonlinear methods and in particular the one based on total variation. We show that this latter permits to avoid these shortcomings [8].

X. Wu and X. Zhang presented a novel non-local iterative back- projection (NLIBP) algorithm for image enlargement. Experimental results demonstrated that the proposed NLBP can reconstruct faithfully the HR images with sharp edges and texture structures. It outperforms the state-of-the-art methods in both PSNR and visual perception [9].

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X. Zhang and X. Wu proposed a soft-decision interpolation technique that estimates missing pixels in groups rather than one at a time. This new image interpolation approach preserves spatial coherence of interpolated images better than the existing methods, and it produces the best results so far over a wide range of scenes in both PSNR measure and subjective visual quality. [10].
W. Dong proposed a novel image fusion based interpolation method. The proposed method combines the advantages of SAI and Bi-cubic together through image fusion. The artifacts in the SAI interpolated image are first detected and then removed by fusing the SAI interpolated image with the bi-cubic interpolated image. Experiments demonstrate the effectiveness of the proposed method. [11]
Neha Tripathi and Krishna Gopal Kirar presented a method for enhancing the quality digital gray images. The proposed enhancement technique is based on the interpolation of the high frequency sub-bands obtained by DWT and SWT. The proposed technique uses DWT to decompose an image into different sub-bands, and then the high frequency sub-band images have been interpolated. Afterwards all these images have been combined using Inverse DWT to generate a super resolved imaged. Further we have made up extra enhancement in the image with the help of the fusion. [12]
Tarun Gulati, Kapil Gupta, Dushyant Gupta focused on Wavelet based Interpolation Techniques in which an input image is divided into sub-bands. Each subband is processed separately and finally combined the processed sub-bands to get the super resolution image. [13]

Shalini Dhiman and Pawan Kumar Mishra [14] have proposed an algorithm for the enhancement of the image resolution considering sub-pixel matching is inaccurate. In the proposed algorithm, the shifts, the gray values of the images of low-resolution and the enhancement ratio are used to calculate the gray values of the higher- resolution image iteratively. Thus, the new image has higher resolution thus has higher definition. Experimental results indicate that the proposed algorithm has many universal applications.

IV. PROPOSED SCHEME

Steps of algorithm are as follows:
Step 1. Input Image; X=”inputImage”;
Step 2. Decomposition of image {Xl,H,V,D}= Lwt2(X);
Step 3. Decomposition with SWT {Xl,H,V,D}=Stw2(X);
Step 4. Improved Interpolation of H,V and D of LWT;
Dx = H,V,D; Direction of edges of MxN;
Rx = One part goes to resize (H,V,D)
Dr = Resize(directed edges(MxN
Correction of misplaced pixel (Rx, Dr);
Ox = interpolated image (2Mx2N);
Step 5. Merge the output of step 4 and step 3
Step 6. Repeat the step 4 for Xl part of LWT
Step 7. Arrange the output of step 5 and step 6 for ILWT
Step 8. Output = ILWT(step7);
Step 9. Parameter calculation;

V. RESULT AND ANALYSIS

A. Input Image

Fig1 . Test Image

B. Output of input image

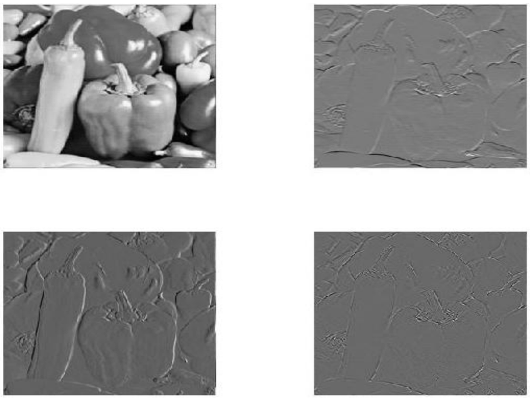

Fig 2. Four band decomposition of test image

C. Resolution Enhanced Output images:
Output images are now presented here with the proposed switching interpolation technique.

Fig 3. Output image of proposed technique

D. From the experiment following discussion can be made:
1. MAE (Mean arithmetic Error) is reduced to 50 to 70% average for almost all the test image.
2. MSE is reduced upto 10 to 15% for test image 1, test image 3 and test image 4. For High frequencies like test image 2 it is reduced to 60% whereas for low frequencies its almost 5% only.
3. SNR is increased to 2 to 5% for all the images.
4. PSNR is increased to 25 to 45% for all the images.
5. RMSE is showing the same behaviour as MSE.
Hence form above results we can conclude that the new proposed resolution enhancement technique is working effectively for the purpose

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VI. IMPORTANT PARAMETERS FOR MEASURING PERFORMANCE

a) Signal to Noise ratio (SNR)
Signal to noise ratio also known as "SNR" of the image is commonly used to measure the performance of all lossy algorithms and calculate the measure of signal strength. So, it gives the ratio between the average power of a signal and the power of corrupting noise which actually affects the fidelity of its representation.

$$SNR = 10\, log_{10}\left(\frac{Avg_i{}^2}{MSE}\right)$$

b) Mean Square Error (MSE)
Mean square error (MSE) is the cumulative squared error obtained between original and processed image.

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}|I(i,j)-K(i,j)|^2$$

Where,

$$I(i,j) = OriginalImage$$
$$K(i,j) = ProcessedImage$$

c) Peak signal to noise ratio (PSNR)
To measure how much attenuation has been done while the processing of a digital image is done from the enhanced image, a distortion measurement is used for a lossy compression algorithm.

$$PSNR = 10\, log_{10}\left(\frac{MAX_i{}^2}{MSE}\right)$$

Here, MAX_i is the maximum possible pixel value of the image. It is 255 generally for unsigned 8-bit gray scale image.

d) Mean Arithmetic Error (MAE)
In addition to above parameters MAE is also calculated using following equation:

$$MAE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left|I_{input}\,(i,j) - I_{output}\,(i,j)\right|$$

e) Root Mean Square Error (RMSE)
Other parameter like RMSE is the square root

$$RMSE = \sqrt{\frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}|I(i,j)-K(i,j)|^2}$$

Small value of PSNR results in the poor quality image. But PSNR is very fast and easy to implement.

VII. COMPARISON OF PARAMETERS

Comparison of parameters for test image.

	Existing Method	Proposed Method
MSE	1235.8187	1074.7601
PSNR	51.6338	71.2708
MAE	29.7965	14.9403
SNR	69.0805	69.6869
RMSE	35.1542	32.7835

VIII. CONCLUSION

In this paper the proposed work is being concluded. PSNR and SNR is increased in the same manner to 25 to 45 % and 2 to 5% respectively for all the images. Mean arithmetic Error is reduced to 50 to 70% average for almost all the test image. MSE and RMSE are shown the same behaviour of reduction to 10 to 15% for test image 1, test image 3 and test image 4. For High frequencies like test image 2 it is reduced to 60% whereas for low frequencies its almost 5% only.
From the above discussion we can conclude the thesis in the note that it is an efficient and good enhancement technique to increase the resolution of the image to 4 times of that of input image. For the future work of the technique we can further improve the method by changing the LWT and SWT by increasing the level of decomposition to get the better level of edge information. By this enhancement we can improve the PSNR and MSE value of the image further

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