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Research Paper

Comparison of Interpolation Techniques for enlarging image with LL Sub-band of IWT transform

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***Abstract*:** Digital images are an important part of the digital world. Majority of transactions are handled through digital images in place of physical image. Electronic security is also the concerned task for digital images. Data hiding techniques are available through which security can be provided to the images. Digital Image Tampering is one of the issues where the actual content of the original image is lost. To hide the data, Integer Wavelet Transform places an important role which can help in hiding data without loss of content. But during tampering the image content may loss the data which can affect the sub-bands which are generated through IWT transform. If during self-recovery stage, if the LL sub-band is retrieved properly then using Interpolation technique, the image can be enlarged. This paper demonstrates the comparison of Interpolation techniques with respect to LL sub-band of IWT transform. As outcome, it is found that Lancoz3 Interpolation technique is better to use as compare to Nearest Neighbor, Bilinear, Bicubic, Lancoz2 interpolation techniques. The outcomes are measured using PSNR, Sum of Absolute Difference and Average of Absolute Difference.

***Keywords*:** Interpolation, IWT transform, Lancozs, Bicubic, Bilinear, Nearest neighbor

1. Introduction

Digital images are now a days an important part of digital media. These images need to enlarge as per the requirement of user. During enlargement of image, the main issue which is under the consideration is about the resolution of the image. When the image is enlarged twice then near to 50% pixels' intensity values need to guess and need to adjust within image. These pixels' intensity must be set in such a way that the quality of original content of the image can be maintained or improved. With the help of Interpolation, the image can be enlarged. This technique estimates the intensity value of the pixel as per the sample pixels intensity values surrounded by the guess pixel.

During data hiding techniques, when IWT frequency transform is implemented then the image is divided into LL,LH,HL and HH sub-bands [1] whose image size becomes half as compare to the original image. During reconstruction, the same reverse process is applied so original data can be derived without any loss [2]. If all sub-bands are available then by implementing inverse IWT transform, Without any loss data can be received properly [3]. But, in the situations like tampering of images, there are not chances to recover all sub-bands' data properly. Here if the LL sub-bands' data are retrieved properly then there is a need to enlarge the image to recover the original image. In this case, Interpolation technique helps in enlarging this LL sub-band to recover the original content of the image. There are many interpolation techniques available like nearest neighbor, bilinear, bicubic, Lanzos2 and Lanzos3 [4]. The outcomes with Inverse IWT can not be compared with Interpolated outcomes but if above mentioned situation arises then Interpolation technique can help. In this paper, the comparative outcomes of different interpolation techniques with respect to specific images and parameters with IWT transformed LL sub-band are discussed. In the paper, reviews of research papers are discussed in Section-2. The implemented algorithm is shown in Section-3. Next Section discusses about the parameters used for testing. Section-5 demonstrated the simulated system outcomes and at last, Section-6 discusses the conclusion.

2. Related Work

Bravo-Solorio et. al. [5] have worked in tampering issue. Authors tried to recover the original content using watermarking technique. They have tried to recover original content by enlarging image using bicubic interpolation technique. Martin Kutter et. al. [6] also worked on blind watermarking technique to recover the tampered image. They have also implemented bicubic interpolation to enlarge the recovered watermarked content. Dey Ashis et al. [7] have worked with reversible watermarking scheme. They proposed new watermarking technique using Integer Wavelet Transform (IWT) and Lagrange Interpolation Technique (LIT) for solving mentioned problem. Ernawan Ferda et. al.

[8] tried to recover the original content of tampered image using Fragile watermarking technique. Here also they used IWT transform for recovery data. The recovery of data is possible only up to 10% of tampering using this technique. Ye Hanmin et.al. [9] also tried to work with reversible image using steganography data hiding technique. The interpolation technique is used with different histogram shifting method. Reddy K. Sreedhar et. al [10] have worked for enlargement of image with better quality. They have proposed Fast Curvature Based Interpolation technique for enlarging image and tried to achieve better quality with enlarged image.

3. Implemented Algorithm

To compare the different interpolation techniques for enlargement of image for IWT transformed LL sub-band, following algorithm is applied.

1. IWT transform is applied to the original color image (I) of size 512X512x3.
2. The image is divided into LL, LH, HL and HH sub-bands. Each sub-band is of size 256x256x3.
3. LL sub-band is used for applying interpolation.
4. Nearest interpolation technique is implemented to the images to enlarge the image twice. Let name this image as (new_I).
5. Calculate PSNR, Sum of Absolute Difference and Average of Absolute Difference using I and new_I.
6. Applying Bilinear, Bicubic, Lancoz2 and Lancoz3 interpolation techniques one by one and calculate the above-mentioned parameters of all.

4. Parametric Evaluation

Peak Signal Noise Ratio (PSNR) is evaluated to compare the imperceptibility of original image (I) and the enlarged image (new_I). As the PSNR increases, the imperceptibility of image is increases. Absolute Difference is also calculated which shows the absolute difference between original and enlarged image and the overall sum of this absolute difference is measured. As the sum of absolute difference decreases the performance is increased. The average of Absolute Difference is also calculated. As the average of absolute difference decreases the image is more similar to the original image. Here total numbers of pixels per image are 512 x 512 x 3 = 786432.

5. Experimental Outcomes

For comparing the interpolation techniques, the simulated model is prepared in MATLAB software. 15 standard color images of size 512x512 are used for testing algorithm which are displayed in Fig-1.

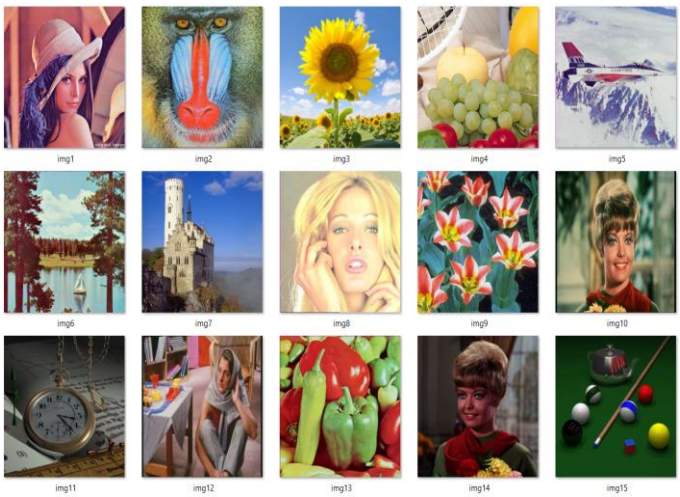

Fig-1: Data set of color standard images of size 512x512

In the paper, the outputs are shown for LENA standard Image. Fig-2 displays the original LENA image and different Interpolated techniques through enlarged images.

Fig-2: Interpolation techniques simulated outcomes

As per the Fig-2, the original image as well as enlarged images with all techniques are looks similar.
The PSNR, Sum of absolute difference and Average of absolute difference with interpolation techniques for LENA image are displayed in Table 1.

Table 1 Interpolation technique outcomes with parameters for Lena Image

No	Interpolation Techniques	PSNR (dB)	Sum of absolute difference	Average of Absolute difference
1	Nearest neighbour Interpolation	35.9946 DB	3470480	4.4129
2	Bilinear Interpolation	37.1463 DB	2958996	3.7626
3	Bicubic Interpolation	37.7069 DB	2589469	3.2927
4	Lanczos2 Interpolation	37.6953 DB	2594312	3.2988
5	Lanczos3 Interpolation	37.8135 DB	2546662	3.2382

By comparing the parametric outcomes with LENA image, the highest PSNR and less sum as well as average of absolute difference are received for Lancoz3 Interpolation Technique.
For all images of Fig-1, list of parameters are calculated and the average outcomes are demonstrated in Table 2.

Table 2 Average Interpolation technique outcomes with parameters as per all images

No.	Interpolation Techniques	PSNR (dB)	Sum of absolute difference	Average of Absolute difference
1	Nearest neighbour Interpolation	36.7650 DB	3221989	4.0969
2	Bilinear Interpolation	38.2132 DB	2707628	3.4429
3	Bicubic Interpolation	39.1168 DB	2335888	2.9702
4	Lanczos2 Interpolation	39.0894 DB	2340205	2.9757
5	Lanczos3 Interpolation	39.3205 DB	2285228	2.9058

The average outcomes are also justified that Lancoz3 Interpolation technique is far better to use as compare to other Interpolation techniques.
If the LL, LH, HL and HH all sub-bands are available with image then Inverse IWT is also implemented for LENA image and the outcomes can be viewed through Table:3.

Table: 3 Inverse IWT and Lancoz3 Interpolation technique outcomes.

No.	Enlarge Technique	PSNR (dB)	Sum of absolute difference	Average of Absolute difference
1	Inverse IWT	INF	0	0
2	Lancoz3 Interpolation	37.8135 DB	2546662	3.2382

As per the Table: 3, it is cleared that when the inverse transform is implemented then the original image and retrieved images looks similar and the respective PSNR is infinitive which shows that there is not a single bit variation in images. The Sum and Average of Absolute Differences are also 0 which shows lossless data extraction. When the LL sub-band is enlarged using Lancoz3 Interpolation technique then achieved PSNR is 37.8135 DB, the Sum of absolute difference is 2546662 whereas average is 3.2382

6. Conclusion

As per the simulated system outcomes, it is cleared that when Integer Wavelet Transform is implemented to the image then it is best choice to implement Inverse IWT if LL, LH, HL and HH sub-bands are presented. But if in any situation if only LL sub-band is available then it is better to use Interpolation technique to enlarge the image. As per simulated outcomes, no one can visibly identify the difference with any of the Interpolation techniques. But when the images are compared with different parameters then it is found that Lancoz3 Interpolation technique is better to use as compare to other Interpolation Techniques. The PSNR is achieved near to 39.3205 DB which is acceptable. The average absolute difference is also near to 3 which is also negligible when we are concern with image content for legal proof. The approximate image can be retrieved properly if the image is tampered with high scale.

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