SATELLITE IMAGE RESOLUTION ENHANCEMENT

D.Swetha[1], G. Tulasi[2], B. Anusha[3], Ch.Mounika[4], D. Revanth[5], G. Shailesh[6]

[1]Assistant Professor, Dept. of Electronics and Communication Engineering, Bapatla Engineering college, Andhra Pradesh, India

[2,3,4,5,6] Dept. of Electronics and Communication Engineering, Bapatla Engineering college,

---

Abstract - *The main objective of this project is to improve the resolution of satellite images. Generally satellite images are having low resolution. Resolution is one of the most important factor for an image. In order to get high resoluted images DWT (Discrete Wavelet Transform), interpolation and IDWT (Inverse Discrete Wavelet Transform) methods are used. The sharpness of an image is improved by estimating the high frequency sub bands and edges are preserved by DWT technique. Based on the visual appearance and quality metric parameters image resolution is improved. This algorithm is applied on LANDSAT 8 images and the method is implemented on MATLAB using image processing toolbox.*

***Key Words*: DWT (Discrete Wavelet Transform), interpolation, IDWT (inverse discrete wavelet transform), LANDSAT imaginary, Remote sensing.**

1. INTRODUCTION

Satellite images are having many applications these days due to the development in the sensor technologies. They are widely used in weather forecasting, oceanography, geographical information etc. The images from satellite are having low resolution because they are affected by some factors like scattering, weather conditions etc. In order to get complete information through the satellite images we need to get high resolution images from satellite since resolution is an important factor for any image. The visibility and clarity of an image depends upon contrast and resolution. So to enhance the quality of an image there are many techniques. DWT (discrete Wavelet Transform) and interpolation can be used to get high resolution satellite images. In DWT an image is decomposed into four sub bands namely LL band, LH band, HL band, HH band using bi orthogonal wavelet which exhibits the property of linear phase. Then after the division of image into sub bands, interpolation technique is applied on each sub band which constructs the new dada points with the range of a discrete set of known data points. There are many types of interpolation techniques like linear interpolation, bilinear interpolation, cubic interpolation, bi cubic interpolation etc. one can choose the interpolation technique as per the requirement.

Image resolution enhancement techniques are categorized into two major classes. They are spatial domain and transform domain. In spatial domain gray level transformation, histogram modeling, gray level slicing, neighborhood pixel adjustments techniques are available. The input image can also be transformed into other transformations like DFT, DCT and SVD to achieve the image resolution enhancement. The proposed paper uses DWT in the starting stage. In intermediate stage interpolation technique is used and finally IDWT is used to enhance the quality of an image.

2. METHODOLOGY

The methodology is as shown in Fig 1. Here, At first image is enhanced by interpolation technique. And the technique is bilinear interpolation. To preserve the edges DWT technique is used. Resolution is an important feature in satellite imaging, which makes the resolution enhancement of such images to be of vital importance. As it was mentioned before, many applications of using satellite images, hence resolution enhancement of such images will increase the quality of the other applications. The main loss of an image after being super resolved by applying interpolation is on its high frequency components (i.e., edges) due to the smoothing caused by interpolation. Hence, in order to increase the quality the quality of the super resolved image, preserving the edges is essential. So that DWT and interpolation techniques are used to get high resoluted image.

2.1 DWT

A Discrete Wavelet Transform (DWT) is any wavelet for which the wavelets are discretely sampled. As with other wavelet transforms, a key advantage it has over Fourier transforms is temporal resolution and it captures both frequency and location information. In DWT, many wavelets are available. Here bi orthogonal wavelet is used and the procedure is, input image is decomposes into different sub bands then input low resolution image and high frequency sub bands of image by DWT are interpolated.

2.2 INTERPOLATION

Interpolation is a technique that reduces the visual distortion caused by the fractional zoom calculation. Interpolation technique have been developed to increase the image resolution. In this paper Bilinear interpolation technique is used to get better image. Bilinear interpolation is an extension of linear interpolation for interpolating functions of two variables on a 2D grid. Interpolation is obtained by interpolating high frequency sub bands by factor

2 and then including the difference image into estimated high frequency images. We get sharper and cleaner image by adding difference image containing high frequency components. Due to interpolation of isolated high frequency components HH, HL and LH frequency components will be preserved.

Finally combine the interpolated sub bands obtained in DWT by performing Inverse Discrete Fourier Transform (IDWT). IDWT is the inverse process of DWT performs a single-level one dimensional wavelet reconstruction with

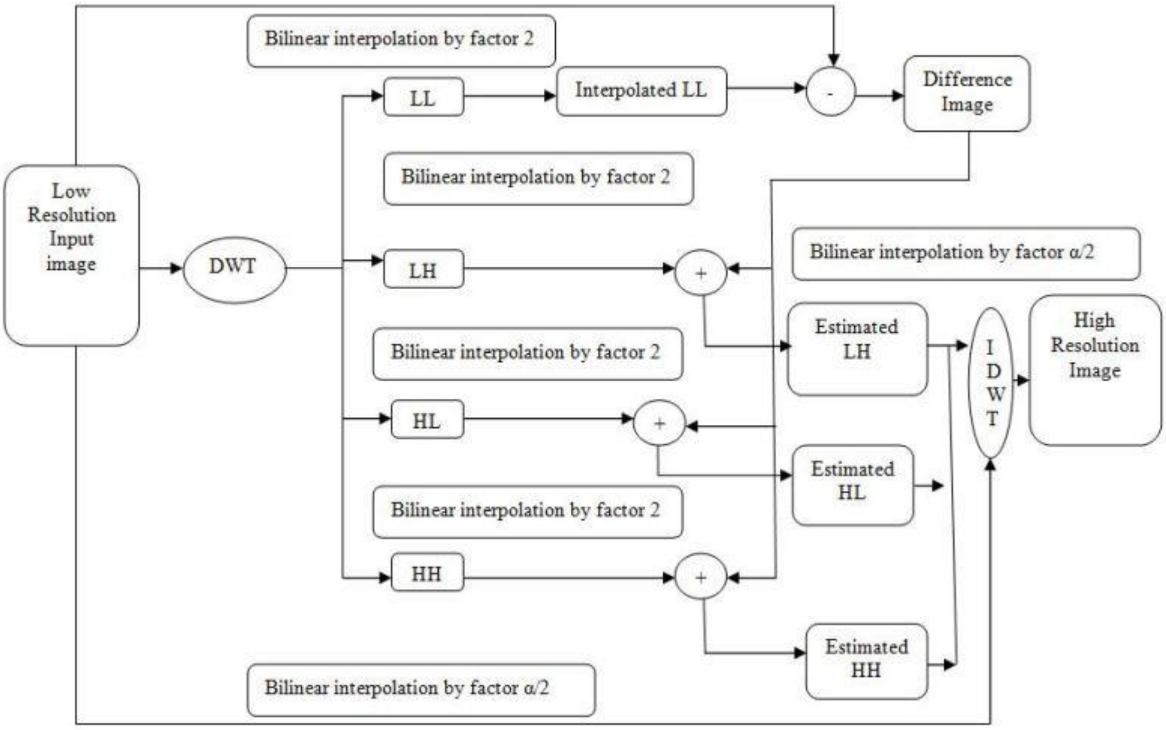


Fig-1. Methodology

2.3 ALGORITHM

1) Discrete Wavelet Transform is applied on the input image which decomposes the image into four sub bands.

2) Interpolation is performed on these four sub bands. The low frequency sub band contains less information as compared to the original input image. Hence original input image is used in the interpolation process.

3) Each sub band of input low resolution image is interpolated by the factor α/2.

4) To preserve edge information interpolation on high frequency sub bands are performed.

5) The difference between the low resolution input image and interpolated LL sub band image generates their high frequency components. This difference image and interpolated LH, HL and HH bands are added to estimate the respective hi components.

6) The resultant estimated high frequency sub band images and interpolated input image interpolation are goes through inverse DWT to get enhanced satellite image of original image.

The proposed method of enhanced is not just interpolated the image but also preserve the high Frequency component of images. So that resultant output image resolution is enhanced.

3. EXPERIMENTAL RESULTS AND DISCUSSIONS

Satellite image enhancement quality is measured using subjective and objective measures. And the original image is denoted by $I_{in}(I, j)$ and reconstructed enhanced image is denoted by $I_{out}(I, j)$. and the size of an image is represented by $M \times N$ pixels. PSNR, MSE and Entropy are used as a objective measures for result analysis. PSNR can be calculated by equation (1)

$$PSNR=10*\log_{10}(R^2/MSE) \qquad (1)$$

Where, R is no. of bits required to represent an image

MSE is the Mean Square Error between the input original image and resultant enhanced image that can be calculated by equation (2)

$$\text{MSE}=\frac{\sum_{i,j}(I_{in}(i,j)-I_{out}(i,j))2}{M\times N}$$

(2)

Image entropy is a quantity which is used to describe business of the image i.e., the amount of information which must be coded by a compression algorithm. Image entropy is calculated with the formula

$$\text{ENTROPY}=-\sum_{i}P_i\log_2 P_i \qquad (3)$$

Where, Pi is the probability that the difference between two adjacent pixels is equal to i and log2 in the base 2 logarithm.

The satellite images with three different locations and feature of 256*256 pixel size are used for comparisons. Table I shows the PSNR values of proposed method is improved as compared with other methods. Table II and III compare the MSE and Entropy performance of the proposed technique with bilinear, bi cubic techniques respectively. The subjective results of the proposed technique are shown in Fig2. The MSE of proposed method is less than the other methods as shown in Table II. The PSNR and MSE are inversely correlated to each other. Entropy of proposed method improves as compare to other methods as shown in Table III. The PSNR values of proposed method are more compared to other methods.

Table -I: PSNR results for 256*256 size satellite image

PSNR(dB)			
METHOD/IMAGE	Fig 2.1	Fig 2.2	Fig 2.3
Bilinear interpolation	35.7471	35.7125	34.5886
The proposed method	40.3306	40.2319	39.1168

Table-II. MSE results for 256*256 size satellite image

MSE(dB)			
METHOD/IMAGE	Fig 2.1	Fig 2.2	Fig 2.3
Bilinear interpolation	32.5923	32.6026	32.7415
The proposed method	32.0745	32.0851	32.2072

Table-III. Entropy results for 256*256 size satellite image

Entropy			
METHOD/IMAGE	Fig 2.1	Fig 2.2	Fig 2.3
Original image	7.0437	7.3262	7.8260
Bilinear interpolation	6.1693	6.4325	7.0017
The proposed method	5.0867	5.3200	5.9259

Fig.2.1(a)

Fig.2.1(b)

Fig.2.1(c)

Fig.2.2(a)

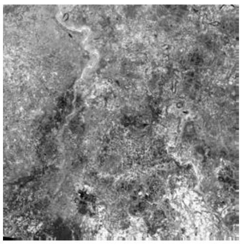


Fig.2.2(b)

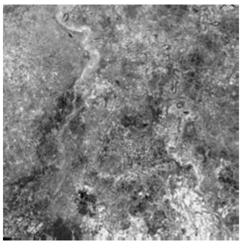
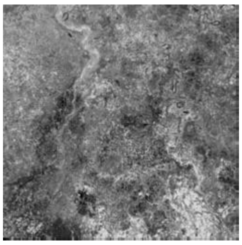


Fig.2.2(c)



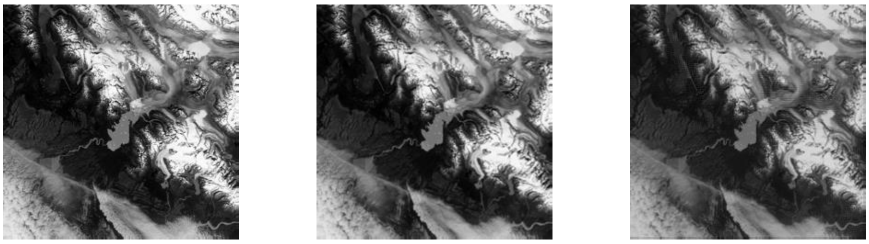


Fig 2. Results (a) original (b) bilinear (c) IDWT

4. CONCLUSION

This paper presents the satellite image enhancement technique based on the interpolation and DWT of high frequency subbands.The proposed technique decomposes an low resolution input image into four subband images, and interpolation is appilied on high frequency sub band images. The interpolation factor of half is applied to the high frequency subband images as well as input image. The performance parameters such as PSNR, MSE and ENTROPY improve as compared to the conventional and state of art methods. In future this technique can be tested on different satellite images and fusion of algorithms is also ossible for further improvements in the result.

REFERENCES

[1] B.D. Jadhav, P.M. Patil, 'An effective method for satellite image enhancement", vol.17, No.4, March 2014.

[2] Parth Bhatt, Ankit Shah, "Image enhancement using various interpolation methods",Vol. 2, No.4, August 2012.

[3] Ravi B. Mehta, Richard Sonaliya, "Survey On Satellite Image Enhancement Techniques", Vol. 5 (6) 2014, 7411-7414.

[4] Prachi R Rajarapollu, Vijay R Mankar, "Interpolation algorithms implementation for image appearance enhancement", Vol. 8, Iss ue 2, April - June 2017.

[5] Dr.P.V Nagarjaneyulu, S.Krishna priya ,"Comparision of image resolution analysis by wzp and decomposition methods",vol.1 (2), 2012.

[6] Thorat Ashwini Anil , Katariya S. S," Image Resolution Improvement By Using DWT & SWT Transform", Vol-1 Issue-4 2015.

[7] USGS landsat8 data download [online] http://landsat.gov/tools_faq.php