Satellite Image Enhancement using DWT and Panchromatic Image

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Abstract- *Image compression is one of the major image processing techniques that is widely used in medical, automotive, consumer and military applications. Discrete wavelet transforms is the most popular transformation technique adopted for image compression. Complexity of DWT is always high due to large number of arithmetic operations. In this paper we are going to learn a new technique for DWT where we are going to use panchromatic image along with the basic DWT technique. The panchromatic image are the 8th band of all 11 bands of satellite image and are most illuminated bands. The use of panchromatic image as the external image in DWT will give the expected results. The visual and numerical results are introduced and examined on LANDSAT 8 information with correlation of proposed technique over customary and condition of workmanship determination improvement strategies.*

Keywords- Discrete wavelet transform, interpolation, LANDSAT Imagery, Remote sensing.

I. INTRODUCTION

The application of satellite imagery is increases day by day due the development in the sensor technologies in weather forecasting, astronomy, geographical information etc. [1] There is a need of have high resolution satellite images. These images are affected by many factors such as absorption scatteringetc. Resolution of these images is very low in space. For enhancement of resolution of satellite image, in the literature many approaches are proposed. To preserve high frequency image details an Adaptive antialiasing algorithm based on the wavelet Fourier transform and directionally adaptive wavelet shrinkage is used[2] [3] .It removes aliasing artifacts by shrinking transform coefficients. A powerful determination improvement approach for pictures, for example, Satellite pictures and additionally ordinary pictures DT-CWT and bi-cubic interpolation is utilized to produce the obscure high determination picture. Cycle spinning methodology is used to produce a decent quality de-noised high determination picture.

One of the important issues of the remote sensing is the resolution of the image which plays the significant role in the real time land cover land use management. According to the domain the Image resolution enhancement techniques can be categorized into two major classes such as spatial domain and transform domain. In spatial domain the different techniques available such as gray level transformation, histogram modeling, gray level slicing, neighborhood pixel adjustments etc. The statistical and geometric data directly extracted from the input image itself. [6][7]The high resolution image is obtained by cycle spinning algorithm along with the multiwavelet transform from low resolution input images. Hence before processing the satellite image for remote sensing application enhancement is important.

The data received through the different sensor have various resolutions. The high resolution data is not available freely. However the low resolution data is freely available and downloadable but the classification accuracy is not good. It affects the performance of classification result. Hence there is a need of resolution enhancement for satellite images. The proposed paper uses DWT in first stage, interpolation as the intermediate stage and IDWT as final stage which in all enhances the quality of the image.

II. METHODOLOGY

The Methodology of proposed paper is as shown in the fig.1.It uses interpolation technique in the intermediate stage to enhance the test image; however it affects the high frequency sub-bands. Hence to preserve edges the DWT technique is proposed. Low resolution satellite image is acquired through the LANDSAT8 TM Multispectral sensor [11]. This sensor provides total eleven bands of data with 30 square meter resolution except one band with every sixteen days temporal rate. The data used for this implementation are the Ahmedabad images retained from Landsat database.

DWT Method Explained: -Wavelet is a small wave which has varying frequency and limited duration. Wavelets have special ability to examine signal simultaneously in both time and frequency domain. The stationary data are analyzed by the Fourier analysis andwavelet transforms are designed for non-stationary data.

The determination is a critical element in satellite imaging, which makes the determination improvement of such pictures to be of fundamental significance as expanding the determination of these pictures will specifically influence the execution of the framework utilizing these pictures as information. The fundamental loss of a picture in the wake of being determination improved by applying introduction is on its high-recurrence segments, which is because of the smoothing created by insertion. Consequently, keeping in mind the end goal to build the nature of the improved picture, protecting the edges is key. In this paper, DWT has been utilized with a specific end goal to save the high-recurrence segments of the picture. DWT isolates the picture into various sub band pictures, to be specific, LL, LH, HL, and HH. High-recurrence sub groups contain the high-recurrence part of the picture. The addition can be connected to these four sub band pictures. In the wavelet area, the low-determination picture is gotten by low-pass sifting of the high-determination picture.

The low-Resolution image band (LL sub band), without quantization (i.e., with twofold exactness pixel qualities) is utilized as the contribution for the proposed determination upgrade process. At the end of the day, low-recurrence sub band pictures are the low determination of the first picture. Hence, rather than utilizing low-recurrence sub band pictures, which contains less data than the first information picture, we are utilizing this information picture through the introduction procedure Hence forth, the information low-resolution image is added with the half of the interpolation factor, α/2, used to add the high frequency sub groups, as appeared in Fig. 5. With a specific end goal to save more edge data, i.e., getting a more keen improved picture, we have proposed a middle of the road stage in high-recurrence sub band addition process. As appeared in Fig. 5, the low-determination information satellite picture and the inserted LL picture with component 2 are exceedingly connected. The contrast between the LL sub band picture and the low-determination info picture are in their high-recurrence segments. Thus, this difference image can be utilized in the intermediate process to correct the estimated high-frequency components. This estimation is performed by adding the high-frequency sub groups by variable 2 and afterward including the difference picture (which is high-recurrence segments on low determination information picture) into the evaluated high-recurrence pictures, trailed by another interjection with element α/2 so as to achieve the required size for IDWT process. The moderate procedure of including the distinction picture, containing high-recurrence parts, produces essentially more honed and clearer last picture. This sharpness is helped by the way that, the insertion of detached high-recurrence segments in HH, HL, and LH will save more high-recurrence segments than adding the low-resolution picture straight forwardly.

III. PROPOSED METHOD

In the proposed method, we have used panchromatic image. In the given technique, after implementing DWT on multiband image, we are getting 4 sub images. Here, we use panchromatic image, and interpolate it with the LL band image. Thus, the information on LL band will get enhanced. Thus all the 4 bands will have good amount of information in them. Thus all the new 4 sub images will be combined again using inverse DWT. We have also implemented loss-less compression as the output images are too high in sizes. The proposed method diagram is shown in the below figure 1.
The discrete wavelets are more suitable for decomposition Compression of images. The equation (1) shows the relation of Wavelet series expansion of function f(x), wavelet ψ(x) and scaling function (x).

$$f\,(x) = \sum k\; Cj0(k)\; j0,k(0) + \sum_{j=j0}^{\infty} \sum_{k} dj(k)\psi j,k(x) \quad \text{-(1)}$$

The above equation maps the function of continuous variable into a sequence of coefficients, when this function is expanded as sequence of numbers the resulting coefficients are called the Discrete Wavelet Transform (DWT) of f(x).The DWT transform pair is as per the equation (2) and (3)

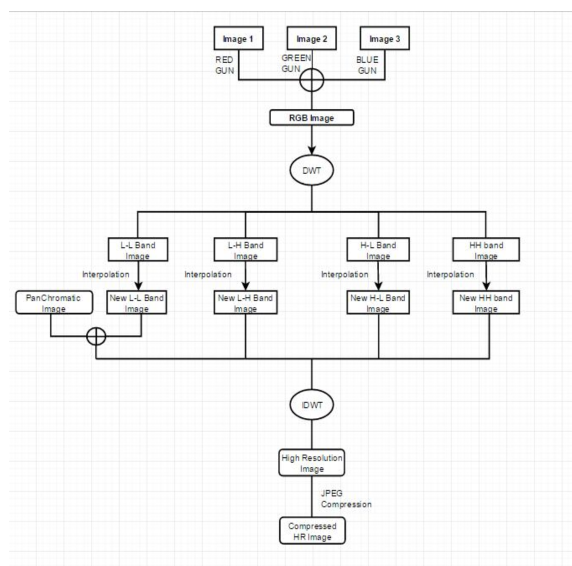

Figure 1 – Proposed DWT method

Algorithm for Proposed Method: -

Step 1-Select 3 images form Landsat 8 database as R, G and B i.e. Red Green and Blue images. The images may vary in terms of information it reveals.

Step 2-Combine those image in form of RGB Color image i.e. the combined form of all three images in single image. The combined image will be in multiband color i.e. the multicolor image.

Step 3-Apply DWT to this RGB image. Thus we will get 4 bands of images i.e. low-low, low-high, high-low and high-high image bands. The DWT technique bifurcates i.e. divides

Step 4- Apply interpolation to all these image bands. The interpolation will decrease the higher components to half or whatever we divide.

Step 5-Combine the interpolated low-low band with the panchromatic image and get a new image. The interpolated image and panchromatic image will give the new image. Both the images are added on one another.

Step 6-Combine the all four images i.e. the new low-low, and other three images using IDWT i.e. inverse DWT. The inverse DWT is the opposite of DWT. It will combine all the 4 images i.e. LL,

Step 7-Compare the results using MSE and PSNR and with standard enhancement techniques.

Step 8- Apply JPEG compression. The JPEG compression will decrease the size of the image. The obtained image will have very much great size in many MBs. Thus in order to decrease the size we apply JPEG compression.

IV. ASSESSMENT CRITERIA

The satellite image enhancement quality is measured using subjective and objective measures. Let the original image is denoted by I_{in} *(i, j)* and reconstructed enhanced image is denoted by I_{out} *(i,j)*.The size of the image is represented by $M \times N$ pixels. PSNR, MSE and Entropy are used as an objectives measures for result analysis. PSNR can be calculated by given equation (2).

PSNR=10 $\log_{10}$ (R^2/MSE) – (2)
Where R is the number of bits required to represent the image.

MSE is representing the Mean Square Error between the original image and resultant enhanced image which can be calculated by equation (3).

$$MSE = \frac{\sum ij(Iin\ (i,j) - i\ out\ (i,j)}{M*N} - \qquad (3)$$

Below given image is the part of Gujarat State. First image (Fig. 2) is the original one. Then the comparison of image is given. The technique used for comparison is edge enhancement technique.

The table shows the MSE and PSNR values.

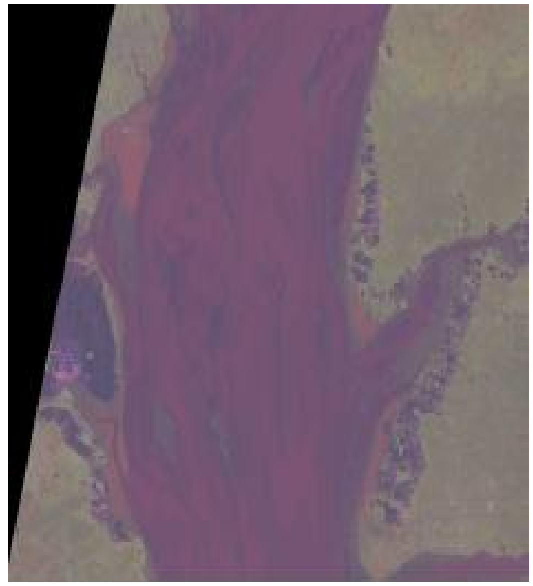

Fig 2. Original image of a part of Gujarat

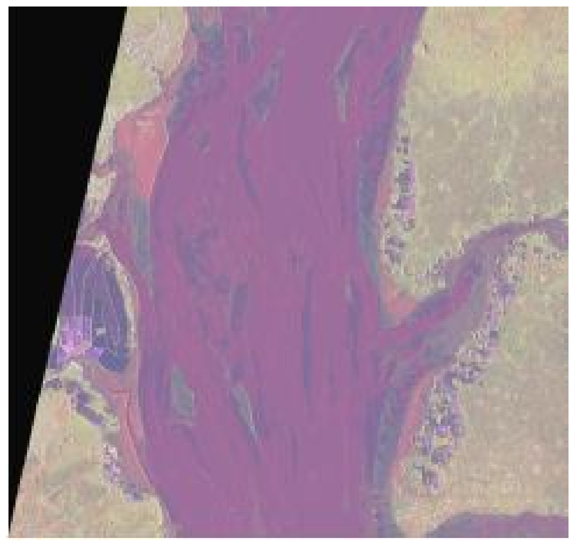

Fig 3. Enhanced image using Edge Detection

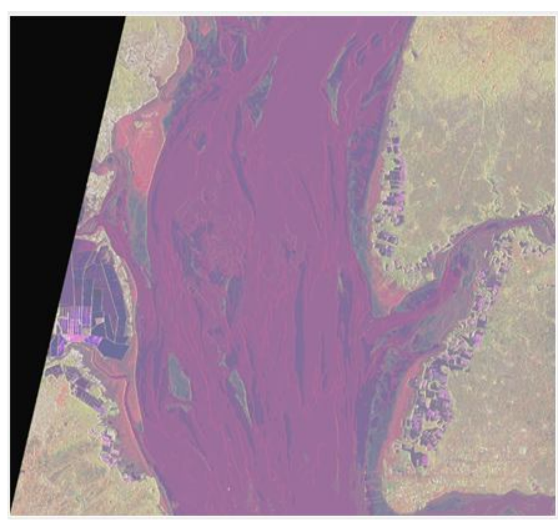

Fig 4. Enhanced image using our technique

The above images Fig.3 and Fig 4 shows the comparison of generated image. Fig 3 is the image generated through edge detection technique. While Fig 4 is the image generated through our proposed method.

The MSE and PSNR value for dataset 1 is given below comparison table is given in table 1.

The RAM consumption graph is shown below. Before optimization and after optimization memory consumption is shown in below graph.

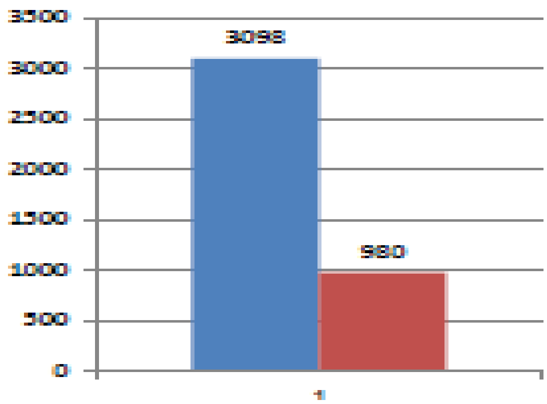

Fig 5- Graph For memory Consumption

Before optimization, the memory consumed by Datasets are:-

Dataset 1 - 3098 MB
After optimization
Dataset 1 - 980 MB

Table 1 (MSE and PSNR Comparison Table)

Method	MSE	PSNR
Edge Detection based DWT	6.078	38.733
DWT with Panchromatic image (Proposed Method)	4.320	42.110

Comparison for dataset 2 images is shown below.

Fig 6 Edge Enhanced image of Ahmedabad.

Fig 7 Proposed method based Image of Ahmedabad

V. CONCLUSION

The approach we are applying to get the more enhanced image of the satellite image. We can see that panchromatic images contain more detailed information as the smallest spot can also be detected. Thus we can know that we will get the definite and better results than the previous techniques. As a part of future work we can combine the services of our DWT implemented model with other application which uses satellite images. We can also use this technique for wider class of images other than satellite images.

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