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Satellite Images Enhancement Using Super Resolution Wavelet and Interpolation Technique with Edge Extraction and Sparse Matrix

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ABSTRACT

In this research letter a super-resolution algorithm using wavelet and Lanczos interpolation technique along with nearest neighbourhood interpolation and sparse matrix is proposed. A good quality of pixels is generated in satellite image by using this novel algorithm. The Sharper images can be generated by high frequency sub bands. The Interpolation method is used between satellite image and HF sub bands through the discrete wavelet transform which preserves edges. The Sparse image is obtained by applying sparse mixing weights to low resolution (LR) image. The Lanczos interpolation is a sinc filter which reduces arti-facts in an image. The High resolution (HR) image is generated by using inverse DWT to LH, HL, HH and modified LL sub band. The proposed method is carried out on Google earth satellite images. The quantitative parameters such as PSNR (peak signal to noise ratio), RMSE (root mean square value), CC (correlation coefficient), EME (Enhancement measurement) are measured for satellite images. The proposed technique i.e., super resolution using wavelet along interpolation and sparse matrix has got better values compared to DWT in terms of quantitative parameters.

Key words- Super Resolution (SR), Edge Extraction, Lanczos Interpolation

1. Introduction

The images in many applications such as medical, optical, radar, and satellite applications are pre-processed, so this proposed algorithm is used for pre-processing the images. Whenever image is enhanced by some enhancement algorithms, some unwanted noise is added. This unwanted noise can be avoided by using de-noising algorithms. The modern advance in low-cost imaging methodologies and enhancing storage space capacities, there is an increased demand for visual quality of image in a wide range of applications involving both image and video processing [1]. Interpolation is one of the known methods in image processing to highlight the resolution of digital image. It increases the number of pixels in a digital image. The Interpolation method selects new pixel from surrounding pixels. Interpolation has been widely used in many image processing applications such as facial reconstruction, multiple-description coding and resolution enhancement [2]. The SR algorithms are economic compared to other sensors, which are used to increase the resolution of images . Recently many SR algorithms have been proposed for increasing the intensity of low resolution pixels. The wavelet based sparse matrix is very much useful for enhancing low resolution pixels [3]. The spatial and spectral pixel details of satellite pictures are highlighted by this proposed algorithm [4]. The

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foremost difference between existing SR based algorithms and proposed novel SR algorithm is in interpolation methods such as lanczos and nearest neighbour interpolation (NNI).This methods are used with some wavelet transforms high frequency sub bands to enhance images. The DWT is used to preserve high frequency sub bands [5, 6]. The DWT is having many disadvantages such as shift and rotation variant, shift sensitive, and absence of phase. Because of these disadvantages there are discontinuities in neighbourhood pixels, which lead to generation of arti-facts [7].

2. Materials and Methodology

The dataset is downloaded from Google Earth site. The software used for processing the data is MATLAB R2018 a.

Algorithm

1. Colour satellite image is acquired from Google earth.
2. Colour image of size 256*256 is converted into gray scale image.
3. Then Wiener filtering is applied to input gray scale image.
4. After filtering operation DWT is applied to the image to preserve high frequency bands.
5. All the high sub bands are passed through Lancoz interpolator with alpha value=2. The Lancoz interpolator is to preserve edges in images.
6. After NNI interpolation is performed two times on high frequency bands to enhance the image.
7. The LL sub band is subtracted from output of wiener filter image and resultant is difference image.
8. The difference image is added to NNI in step 6.
9. Sparse matrix coefficients with alpha value 2 are calculated to the output of the filter.
10. Finally IDWT is calculated for the sparse output and three high bands from step 8.
11. The super resolution image is the output image after IDWT operation.

3. RESULTS AND DISCUSSIONS

The input satellite image is shown in Figure 1. The LL band image is depicted in Figure 2. In the similar manner HH, HL, and LH bands are generated. The Figure 3 presents difference image of input image and filtered output. The Figure 4 shows the output of HH band after double NNI operation. The Figure 5 depicts the output for LH band after double NNI operation. The Figure 6 depicts final super resolution image for satellite images. The Table 1 presents various quantitative metrics such as PSNR, RMSE, CC, and EME. The proposed method has got PSNR of 22.61 Db, RMSE of 18.95, CC of 0.937, and EME of 50.27. The proposed method outperform the existing DWT+SWT (Stationary Wavelet Transform) method in terms of quantitative parameters.

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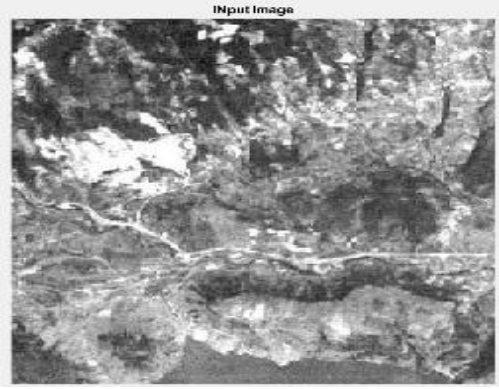

Fig. 1: Input satellite image

Fig. 2: LL Image

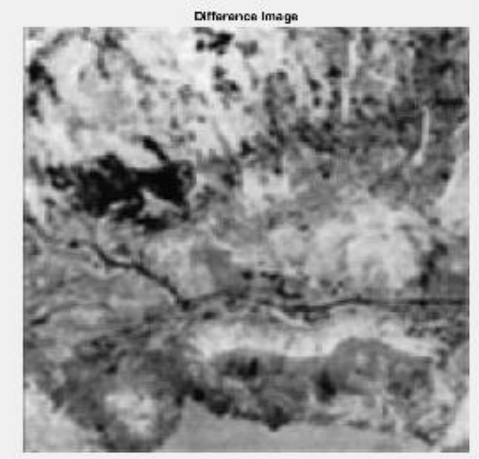

Fig. 3: Difference image

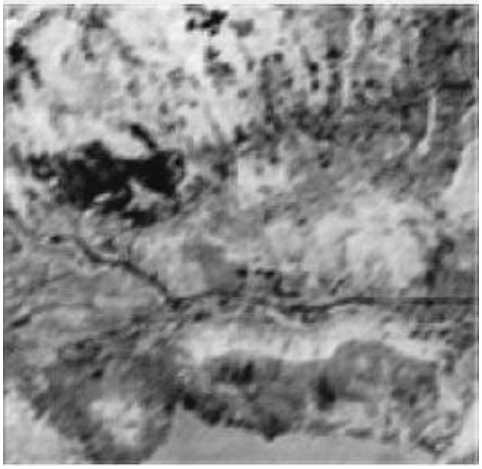

Fig. 4: HH band after NNI interpolation

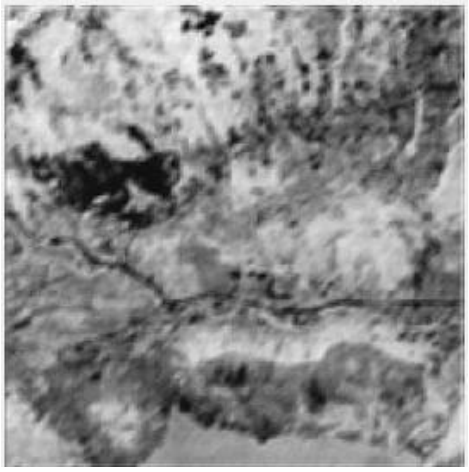

Fig. 5 LH band after NNI interpolation satellite image

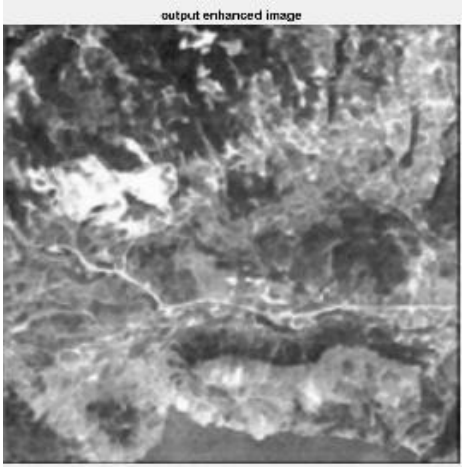

Fig. 6: super resolution output for

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Table 1: Performance metrics for Super resolution algorithm

Parameter	DWT+SWT	DWT+ Lancoz Interpolation+ Nearest Neighbour Interpolation+ Sparse Matrix
PSNR	21.48	22.61
RMSE	17.23	18.95
CC	0.836	0.937
EME	48.49	50.27

4. CONCLUSION

A novel super resolution algorithm has been proposed to get good quality of pixels in satellite pictures. The DWT has been applied for high sub bands and a modified LL band has been generated by difference operation. Then lancoz interpolation has been performed. After that NN Iwas carried out on the resultant image. Finally inverse DWT was applied to the output of second NNI and the modified LL band. The output was super resolution image with good visual appearance. The proposed technique outperformed in terms subjective and objective perception compared to existing methods.

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