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Super Resolution Image Achievement through Edge Extraction and Non Local Means via Wavelet Domain

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ABSTRACT: This letter addresses the subject of generating a super resolution image (SR) image from one low-resolution (LR) input image with in the wavelet domain. To attain a high resolution image, an intermediate stage for estimating the high-frequency (HF) sub bands has been planned. This stage includes edge preservation procedure and mutual interpolation between the input LR image and therefore the HF sub band pictures, as performed via the separate wavelet transform (DWT). On the other side the low resolution image is subjected to Non Local Mean(NLM) filter and the output along with the HL,HL and LH sub bands undergoes IDWT process to produce the high resolution image.The output obtained clearly indicates that our proposed method provided better results in both objective and subjective criteria.

KEYWORDS: Interpolation; Edge Extraction; Super Resolution; Wavelet Domain.

I. INTRODUCTION

The images and video sequences that are obtained from multiple fields like radar, optical, medical and that are telecasted on high-definition television, in electron microscopy, etc., are obtained from electronic devices that use a variety of sensors. Thereby, a preprocessing technique that allows enhancement of image resolution should be used. This step can be done by estimating a high-resolution (HR) image $x(m, n)$ from the low-resolution (LR) image $y(m, n)$ data that were obtained through a linear operator V that forms a degraded version of the unknown HR image, which was additionally contaminated by an additive noise w(m,n),ie.,

$$Y(m,n)=V[x(m,n)]+w(m,n) \qquad \text{EQ (1)}$$

In most applications, Vis a sub sampling operator that should be inverted to restore an original image size,. In most of the monitoring and sensing radars low resolution sensors with cheap and simple hardware is used like unfocused SAR systems and low resolution optical cameras etc., however such cheap sensors provides low spatial resolution and the system suffers from uncertainties which results in random signal perturbations and imperfect system calibration. Hence the SR algorithms that are economical have an important application in the processing of satellite or aerial images obtained by radar or optical sensors [1],[2]. Many resolution enhancement novel algorithms have been proposed[3],The prior image sparsity information is widely used for image interpolation[4],but the main idea behind the restriction of sparse representation algorithms is that SR results can be enhanced by using the data on image properties.

II. RELATED WORK

The predominant challenge of this study is to employ an approach that is similar to the approach of these wavelet-based algorithms, accounting for both spatial and spectral wavelet pixel information to enhance the resolution of a single image. The principal difference of the novel SR approach in comparison with existing methods consists in the

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mutual interpolation via, [6] nearest neighbor interpolation (NNI) and lancoz interpolation[5],techniques for wavelet transform (WT) high-frequency (HF) subband images and edge extracting images via discrete wavelet transform (DWT); additionally, an adaptive directional LR image interpolation is computed by estimating sparse image mixture models in a DWT image. To gain robustness for the SR process in presence of noise, the novel framework uses special filter foe denoising, i.e the non local means (NLM) method for the input LR image [7] and Finally, all of the subband images are united, reconstructing via inverse DWT (IDWT) the output HR image that appears to represent the superiority of the designed algorithm and provides better output than [8] and [9].

A.**PRELIMINARY**:

The Non Local Mean(NLM) filter which is an extension of neighbourhood filtering algorithms is dependent on the assumption that the image content is likely to repeat itself within some neighbourhood in the image [14] and also in neighboring frames [15].The NLM algorithm is used in the denoising stage of this proposal estimates a pixel x(m,n) by applying the weighted mean of the neighborhood noise-contaminated pixels y(m,n) is performed as follows[7].

$$x(m,n) = \frac{\sum(r,s)\in Q(m,n)y[r,s]W[m,n;r,s]}{\sum(r,s)\in Q(m,n)W[m,n;r,s]} \qquad \text{EQ (2)}$$

where Q(m,n) is the neighbourhood of the pixel y(r,s) and the other term W[m,n;r,s] is the weight for the (m,n)th neighbor pixel.

III. **PROPOSED SUPEER RESOLUTION TECHNIQUE(DWT-NLM-SR)**

The block diagram representing our PSRT novel method is as follows

A.Block Diagram:

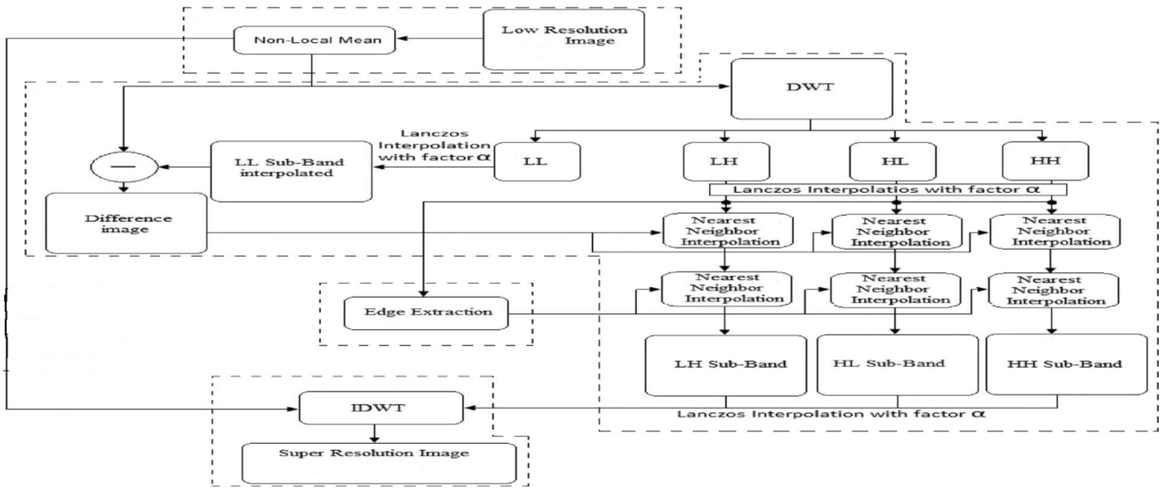

Fig: Block Diagram Of Our Super Resolution Enhancement Technique

In this proposed method, DWT with Daubechies Wavelwt(db1) is used to decompose an input image.DWT separates an image into different subband images,namely,LL,LH,HL and HH in which the last three subbands contain high frequency components of the image.The interpolation process is implemented further to reconstruct the high frequency image through them and to suppress the noise influence,the novel method impliments a denoising procedure by using NLM technique for the input LR image as seen in figure1 and Lancoz interpolation is applied to the LL sub band and the difference between the LL subband image and the LR input image are in the HF(High Frequency)

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components,which is why this intermediate process is used to correct the estimated Hf components applying the difference is proposed.the difference is also performed in the HF sub-bands by interpolating each band through Nearest Neighbor Interpolation(NNI) i.e changing the values of a pixels in agreement with the closest neighborhood values and including additional Hgh Frequency(HF) features into the HF images.Apart from this to preserve more edge information and to obtain a sharper enhanced image an extraction step of the edges is proposed using HF subbands HH,HL and LH images and the resultant information is used in the HF sub-bands employing the NNI process as shown in the figure below.The edge extraction step is calculated using the following equation shown below[12].

$$E = \sqrt{HH^2 + HL^2 + LH^2} \qquad \text{EQ (3)}$$

In the concluding stage an additional interpolation with lancoz interpolation of order 2 is used to reach the required size of the IDWT process as shown in the above figure.Here we notice that an intermediate processs of adding the difference image and the edge extraction stage contains the additional HF features,generates a significantly sharper reconstructed image of super resolution.The sharpness is improved by the fact that the interpolation of the isolated high frequency(HF) componentsin HH,HL and LH preserves mor HF components than interpolating the LR image directly.

IV. Simulation Results

This theory represents the results of statistical simulations and performance evaluation via objective metrics known as mean absolute error,peak signal to noise ratio,structural similarity index measure[13],In addition a tabular comparision is done for our novel method and the several super resolution algorithms which shows that qualitative output is achieved by our method in objective analysis with the help of nlm filtering process which deblurs the input image and helps to extract high frequency data when interpolation is performed.numerous radar satellite and optical images are taken from[10] and [11] which has different nature and physical characteristics.

DIFFERENT LOW RESOLUTION SATELLITE(256*256) AND VIDEO FRAME IMAGES TAKEN FROM [10]&[11]	DWT using NLM filter				DWT With out NLM filter[16]			
	PSNR	SSIM	MAE	Sharpness	PSNR	SSIM	MAE	Sharpness
5.1.0 sat image	19.503	0.884	3.6917	22.48432	16.244	0.746	3.323	18.4586
4.1.04 image	33.7308	0.792	5.6218	39.3526	29.876	0.611	4.9807	34.7282
4.1.08 video scale image	46.265	0.692	9.8722	53.7694	43.366	0.528	8.870	47.2797
5.1.14 sat images	21.639	0.763	4.263	25.0765	19.832	0.736	3.876	20.8276

Table-1:Comparision of 8-bit gray scale Satellite and Optical images using the attributes like PSNR,SSIM,MAE and sharpness using NLM filter and with out NLM filter

In our method daubechies(Db1) classic wavelet function is used and achieved better results than DWT[16] and SWT[17] via objective manner.As we can see in the above tabular form that there is an enhancement of the image when NLM filter is used as a result our method provides better results in wavelet domain .

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V. Conclusion and Future Work

In this letter, a novel resolution-enhancement technique based on the interpolation of the HF subband images in the wavelet domain has been presented. In contrast with other state-of-the-art resolution-improvement techniques, the designed framework applies the edge and fine features information that is obtained in WT space, and uses the NLM denoising algorithm for the SR restoration. Experimental results highlight the superior performance of the proposed algorithm in terms of objective criteria, as well as in the subjective perception via the human visual system, in comparison with other conventional methods and further changes in the classic wavelets used in the DWT and IDWT there is a possibility of further enhancement in our method.

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