Edge Preservation and Smoothing Noise Technique for the Applications in Super –Resolution of Images

Muthu lakshmi.G
PG scholar,
Electronics and communication
Tagore Engg College
Chennai,india

Vidhya lakshmi.M.K
Assistant professor,
Electronics and communication
Tagore Engg College
Chennai,india

Murali.T
Assistant professor,
Electronics and communication
Tagore Engg College
Chennai,india

ABSTRACT
In this paper multiple image super resolution is performed by using maximum likelihood estimation method in spatial domain. Various methods have been proposed to achieve multiple image super resolution, but most of the existing methods having drawbacks that they cannot reconstruct the edges present in an image properly and having inverse problem due to impulse and Gaussian noises. In this paper in order to preserve edges and to reduce Gaussian and impulse noises present in an image maximum likelihood estimation method is used in order to reconstruct the high resolution image effectively. The noises can be reduced by using Gaussian and linear filters and edges are preserved by using gradient descent method. The mean square error value of the input and output images are calculated. Finally the mean square error value of the output images are minimized by different iterations and high resolution image has been reconstructed with edge preservation

Keywords
Maximum likelihood estimation, Gaussian noises, impulse noises, mean square error.

1. INTRODUCTION
Super resolution image reconstruction refers to a process of creating a high resolution image from a single or multiple low resolution image(s). The main goal is to extract the useful information or required image details. Several super resolution reconstruction techniques have been proposed, which can be mainly divided into two types: Multi image super resolution [1] and Single image super resolution [2]. Images with high pixel density are always desirable in almost all imaging applications. E.g. medical imaging, satellite imaging, video surveillance, high definition television broadcasting, microscopy, digital mosaicing etc. For such applications scientists have applied software resolution enhancement techniques, which termed as Super Resolution (SR) reconstruction techniques. The goal of super resolution technique is to reconstruct a high resolution image from a single or multiple low resolution image(s). While in the single image SR technique only a single image is available to work on and the problem is even more under constrained, as the image detail is limited. Example or Learning Based SR. Basically in Example based SR techniques [1], the high frequency information of the given single LR image is enhanced by retrieving the most likely high frequency information from the given training image samples based on the local features of the input LR image. In multi-image super resolution [1] high resolution (HR) image is reconstructed from the multiple observations of the same low resolution (LR) input image. In order to reconstruct a HR image, the LR frames are shifted with respect to the HR grid differently from each other and with sub-pixel increments. As each LR frame has inimitable information which cannot be obtained from other LR frames and this is subjugated to get a HR image. Wavelet domain based methods [3], [4], [5] having the main drawback that they cannot capture anisotropic discontinuities because wavelet transforms are basically isotropic. Most of the existing methods are fails to preserve image edge details and having inverse problem due to noises.

In this paper section (I) Introduction about single and multiple image super resolution methods are provided, in section (II) maximum likelihood estimation method steps are explained and in section (III) simulation results and discussions are provided, in section (IV) input and output images are represented, in section (V) conclusion based on simulation results are provided

2. MAXIMUM LIKELIHOOD ESTIMATION
Maximum-likelihood estimation (MLE) is a method of estimating the parameters of a statistical model. When applied to a data set and given a statistical model, maximum-likelihood estimation provides estimates for the model's parameters.

The method of maximum likelihood corresponds to many well-known estimation methods in statistics. Most statistical methods are designed to minimize error. Choose the parameter values that minimize predictive error: $|y - y'|$ or $(y - y')^2$.Maximum likelihood estimation seeks the parameter values that are most likely to have produced the observed distribution. Maximum-likelihood estimation (MLE) method used to extract the useful information from the input images. When applied to a data set and given a statistical model, it provides estimates for the model's parameters.

This method corresponds to many well-known estimation methods in statistic. First four low resolution images are generated by adding linear and Gaussian noise factors then by using maximum likelihood estimation method the Gaussian and linear noises reduced and edges are preserved finally the high resolution image is reconstructed and their MSE values are calculated with different iterations.

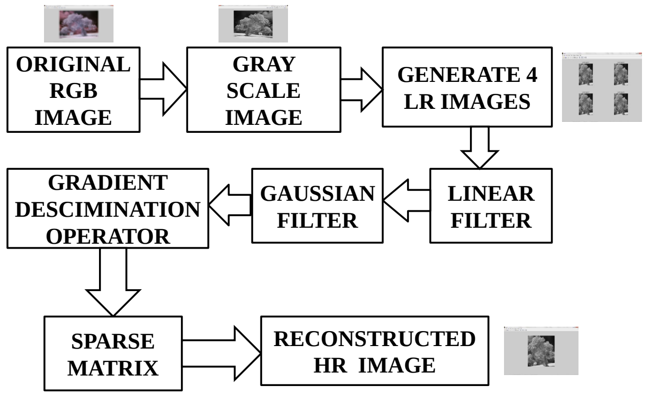

Fig 1: Representation of maximum likelihood estimation steps

2.1 Gaussian Filters Used as a Low Pass Filter

Gaussian filters have the 'minimum time-bandwidth product' in image processing; one very important task is to remove white noise, all the while maintaining salient edges. This can be a contradictory task - white noise exists at all frequencies equally, while edges exist in the high frequency range. In traditional noise removal via filtering, a signal is low pass filtered, which means that high frequency components in the signal are completely removed. But if images have edges as high frequency components, traditional low pass filtering will also remove them, and visually, to remove noise, but also preserve high frequency edges Gaussian kernel.

The Gaussian filter does not have a sharp cut off at some pass band frequency beyond which all higher frequencies are removed. Instead, it has a graceful and natural tail that becomes ever lower as the frequency increases. This means that it will act as a low pass filter, but also allow in higher frequency components commensurate with how quickly its tail decays. This allows attaining the best of both worlds - noise removal, plus edging preservation. One further useful property of 2D Gaussian filters is that they are separable.

Gaussian filter is used to reduce Gaussian noise and to preserve the edges present in an image. It acts as a low pass filter but also preserve the edges while reconstructing the high resolution image. Because the cut off range of low pass filters are fixed, so it allows only the low frequency components. But the cut off range of Gaussian filters are not fixed. So it preserves edges present in an image.

2.2 Spatial Linear Filtering and the Gaussian Filter

Gaussian filters are used to soften a selected area or an entire image and are useful for retouching images that feature unwanted artifacts such as noise. They smooth transitions by averaging the pixels next to the hard edges of defined lines and shaded areas in an image. Each pixel in the image is replaced by a weighted average of its neighbours, as calculated by a mask. A mask is a fixed-size matrix. HR image reconstruction achieved by two methods. Gradient descent operator, sparse toeplitz matrix.

2.3 Gradient Descent Operator

The gradient descent method is used to perform the following operations (a).Image restoration in order reduce the Gaussian and linear noises present in the image and to restore the high resolution image without loss. (b).Image reshaping in order to preserve the image edge details while reconstructing the HR image.

The gradient descent method steps are provided by this flow chart.

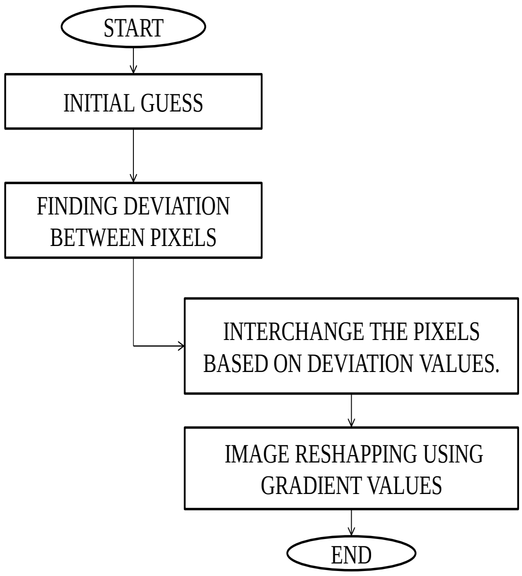

Fig 2: Gradient descent method steps

2.4 Sparse Toeplitz Matrix

Toeplitz matrix Used to find out missing pixels in image reconstruction process. A Toeplitz matrix is defined by one row and one column. A symmetric toeplitz matrix is defined by just one row. Non symmetric toeplitz matrices given just the row and column description.

T = toeplitz(c, r) (1)

Returns a non symmetric Toeplitz matrix T having c as its first column and r as its first row. If the first elements of c and r are different, a message is printed and the column element is used.

T = toeplitz(r) (2)

Examples , A Toeplitz matrix with diagonal disagreement is

c = [1 2 3 4 5];

r = [1.5 2.5 3.5 4.5 5.5];

Toeplitz(c, r)

Here the Column wins diagonal conflict the matrix structure given as,

1.000	2.500	3.500	4.500	5.500
2.000	1.000	2.500	3.500	4.500
3.000	2.000	1.000	2.500	3.500
4.000	3.000	2.000	1.000	2.500
5.000	4.000	3.000	2.000	1.000

This returns the symmetric or Hermitian Toeplitz matrix formed from vector r, where r defines the first row of the matrix. The missing pixel values of the image can be easily found by using this matrix. The high resolution image is reconstructed by using gradient descent method and missing pixel values recovered by using sparse toeplitz matrix.

3. RESULTS AND DISCUSSIONS

3.1 Parameters for the analysis of images (mean square error)

Mean square error is the term which is used to analyze the quality of the image.The edge preservation and smoothing noise techniques are used to minimize the mean square error value of the input images.if the mean square error value of the images are minimized it will have better quality.

Formula:

$$EMSE = 1/n2 * \sum_{k=0}^{n-1} \sum_{i=0}^{n-1} (B\text{^}[k,i] - X[K,i]) \qquad (3)$$

Where,

B^ [n, n] is the restored image

X [n, n] is the original image

The edge preservation and smoothing noise techniques using maximum likelihood estimation used to reconstruct the high resolution image from multiple low resolution images. This method is applied to various images and their mean square error value is calculated.in this method the Color image is converted into gray scale image in order to reduce processing time to increase memory size and efficiency.

The original image is degraded in order to produce four low resolution images. The Gaussian noise and impulse noise factors added to the original image in order to generate noisy version of original image and by using maximum likelihood estimation method high resolution image has been reconstructed. The MSE value of the output high resolution image is minimized by different iterations using maximum likelihood estimation method with edge preservation and noise reduction

4. INPUT AND OUTPUT IMAGE REPRESENTATION

This method is suitable for all kind of images in order to minimize the mean square error and reconstruct the high resolution image.

4.1 Infrared image

First this method is applied to one Infrared image fig 3 represents the original RGB image and fig 3.1 represents the gray conversion of IR image.

Fig 3: Original image

Fig 3.1: Gray Scale image

Fig 3.2 represents the noisy version of original image which is generated by the original image and Fig 3.3 represents the reconstructed HR image**.**

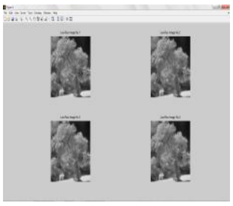

Fig 3.2: LR images

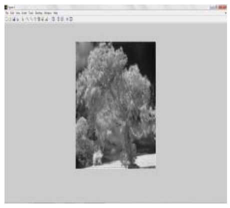

Fig 3.3: HR image

4.2 Satellite image

This method is applied to another satellite image and their corresponding input and output mean square error values have been calculated. The original image is shown by fig 4,

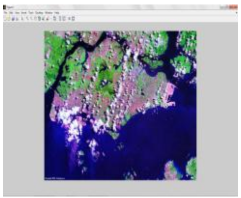

Fig 4: Original RGB image

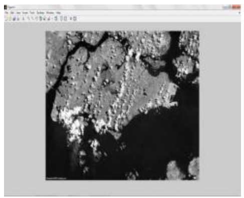

Fig 4.1: Gray scale image

Original image is converted into gray scale image as shown by the fig 4.1. The noisy images can be generated by applying noise factors to the original image. The generated four low resolution images are shown by the fig 4.2

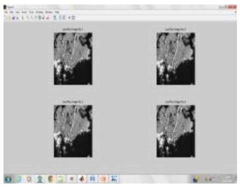

Fig 4.2: LR images

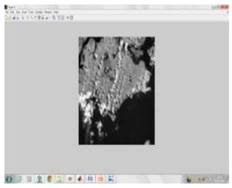

Fig 4.3: Output HR image

The reconstructed high resolution image is shown by the fig 4.3.

4.3. Multi spectral image

This method is applied to multi spectral image. The original image is shown by fig 5.and converted into the gray scale image as shown by fig 5.1.

Fig 5: Original RGB image

Fig 5.1: gray scale image

The noisy image generated by applying noise factor is represented by fig 5.2

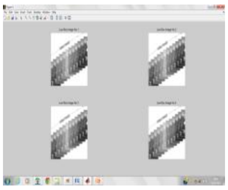

Fig 5.2: LR images

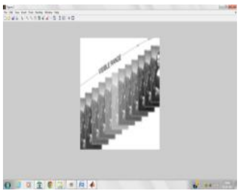

Fig 5.3: output HR image

Finally the reconstructed high resolution image is represented in fig 5.3 and mean square values of input and output images have been calculated.

The edge preservation and smoothing noise techniques using maximum likelihood estimation used to reconstruct the high resolution image from multiple low resolution images. This method is applied to satellite and multi spectral images and their mean square error values are tabulated. This method will be suitable for medical images also.

4.4 Ultra Violet image

This method is applied to the ultra violet image and their mean square error values have been evaluated. The conversion of RGB to gray is represented by the fig 6 and fig 6.1.

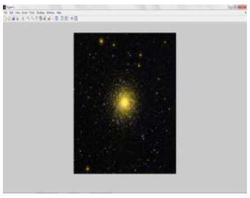

Fig 6: Original image

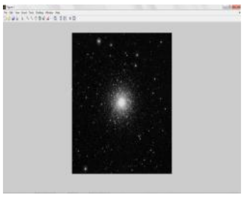

Fig 6.1: Converted gray image

Their corresponding generated four low resolution image is shown by the fig 6.2**.**

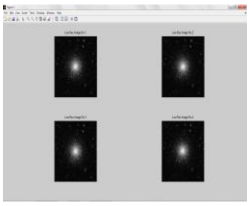

Fig 6.2: LR images

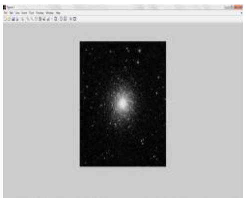

Fig 6.3: Output HR image

Their output high resolution image which is generated by maximum likelihood estimation method is shown by the fig 6.3.The mean square error values of these images have been calculated with different iterations and their corresponding values are tabulated.

5. RESULTS AND DISCUSSIONS

Table 1. Mean square error values of input and output image

ORIGINAL IMAGE	MSE VALUE OF IMAGE	MSE VALUE OF OUTPUT IMAGE IN DIFFERENT ITERATIONS(I)			
		I=50	I=100	I=150	I=200
INFRARED IMAGE	8.360	0.006	0.003	0.002	0.001
SATELLITE IMAGE	25.694	0.006	0.003	0.003	0.002
MULTI SPECTRAL IMAGE	8.810	0.007	0.004	0.003	0.002
UV IMAGE	2 .349	0.000	0 .000	0.000	0.000

This method will be used to reconstruct the high resolution image from multiple low resolution images and in this work the super resolution has been achieved for different kind of images and their mean square error values have been calculated as shown by the above table. The mean square error values of output images are minimized by different iterations. The output high resolution images will have good quality.

6. CONCLUSION

The edge preservation and smoothing noise techniques using maximum likelihood estimation used to reconstruct the high resolution image from multiple low resolution images. This method is applied to various images and their mean square error values have been calculated as shown by the above table. So the mean square value of the input low resolution images minimized by smoothing noise and edge preservation techniques and MSE values of output images are minimized by different iterations. This method can be used to reconstruct the satellite images, multi spectral images and medical images. In future work can design the hybrid model with two techniques maximum likelihood estimation and adaptive convergence criteria for multiple image super resolution which is used to preserve edges and for smoothing noises present in the lower resolution images. So the reconstructed output high resolution images will have good quality.

7. REFERENCES

[1] Changhyunkim, Kyuhachoi, kyuyounghwang, and Jongbeomra "Learning-based Super-resolution Using a Multi-resolution Wavelet Approach" School of Electrical Engineering and Computer Science, Kaist Year of 2012.

[2] Chintan k.modi, Milan n. Bareja Electronics & Communication Engineering "An Effective Iterative Back Projection Based Single Image Super Resolution Approach" 2012 International Conference on communication systems and network technologies.

[3] Guillaume Lemaitre, Heriot-watt university, Universitat de Girona, University De Bourgogne "Image analysis: an introduction to Super Resolution Using Wavelet."

[4] Gajjar, P.P.Dhirubhai Ambani Inst. of Inf. & Commun. Technol., Gandhi agar, India Joshi, M.V. "New Learning Based Super-Resolution: Use of DWT and IGMRF Prior "Year of 2010.

[5] H c liu1, Y Feng1 and G Y sun2. "Wavelet domain image super-resolution reconstruction based on image pyramid and cycle-spinning" Year of 2006.

[6] Heng su, Liang tang, ying wu, senior member, IEEE Daniel Tretter, and Jie Zhou, Senior member, IEEE "Spatially Adaptive Block-Based Super-Resolution". IEEE Transactions On Image Processing, Vol. 21, No. 3, March 2012.

[7] Min Chen1, Guoping Qiu1and Kin- Man Lam2. "Example Selective And Order Independent Super Resolution" Year Of 2012.

[8] Shubinzhao, Huahan and Silong Peng "HMT-Based Image Super Resolution" Year Of 2003.

[9] Weisheng Donga, b. Lei Zhangb, Guangming Shia, Xiaolin WUC "Image Deblurring And Super-Resolution By Adaptive Sparse Domain Selection and Adaptive Regularization" Year Of 2009.