International Journal of Research in Engineering, Science and Management
Volume-3, Issue-7, July-2020
journals.resaim.com/ijresm | ISSN (Online): 2581-5792

Image Super-Resolution and Denoising Using Block Diagonal Representation

Nijumol Puthiri Kochunny[1*], Ashibet Baby[2]

[1]*M. Tech. Student, Department of Electronics and Communication Engineering, Indira Gandhi Institute of Engineering and Technology, Kothamangalam, India*

[2]*Associate Professor, Department of Electronics and Communication Engineering, Indira Gandhi Institute of Engineering and Technology, Kothamangalam, India*

*Corresponding author: nijumolpk@gmail.com

***Abstract*: Single image super resolution is the procedure of achieving a high resolution image from a low resolution image without any loss in the textural and structural information. First we apply the rational fractal interpolation model in the texture and non-texture region. Next, we develop an algorithm based on the proposed model. The scaling factor in the texture region is to be calculated. Even though our algorithm achieves a competitive performance with finer details, enhancing the sparsity will give a better result. Multispectral image denoising is attained using block diagonal representation. We generalize patch level representation via block diagonal matrix, investigate the proper choice of patch level transform and modifies through Single Value Decomposition(SVD). We demonstrate that a very competitive performance can be obtained through the combination of a proper global patch basis and local PCA.**

***Keywords*: Block diagonal representation, Colour image denoising, Image super-resolution, Multispectral image denoising, Rational fractal interpolation.**

1. Introduction

Super resolution is a process that can create a higher resolution image using one or more low resolution images of the same object. The technique of rational fractal interpolation is employed in the process of super resolution. Image denoising improves the quality of image after super resolution. It can be attained by the BM3D algorithm that integrates the nonlocal filters and transform domain techniques. Interpolation based methods approximate the unspecified pixels in the HR grid by taking on their specified adjacent pixels. In image super resolution restoration, a deep learning approach presented an end-to-end mapping between the low resolution and high resolution images.

2. Image Super Resolution and Denoising

A. Rational Fractal Interpolation

Initially, the scaling factors are precisely computed by using the image local structure feature, based on the relationship between the scaling factors and fractal dimensions. The next step is to use the rational fractal interpolation and rational interpolation in the texture and non-texture region respectively. Individually, each LR image patch is first interpolated and then extended to the entire image by passing through each patch. In this way, an HR image is obtained by pixel mapping.

B. Block Diagonal Representation

A 4D transform is used for CBM3D which can cause a little confusion, because after a definite color space transform, the original R, G, B channels are determined individually in the new colour space. This can also hold for 4DHOSVD if all mode transforms are acquired. Therefore, it may be expected to re-plan as independent channel-wise transform. Here, we first extrapolate patch level representation via block diagonal matrix, then discuss the proper choice for patch level basis, and describe how it could be properly included into the block diagonal representation and effectively applied to image denoising.

The BM3D method is extensively adopted to handle grayscale image. Initially, two main solutions are presented to improve the channel by channel or band by band approach. The original image is converted into a less correlated color or band space, such that denoising in each converted channel or band could be carried out separately. The influence of the patch level representation is less carefully studied in many of the competitive methods to approach the ideal performance. The necessity of single-image super-resolution (SR) is to reconstruct a latent high-resolution (HR) image using a single low-resolution (LR) input. SR is a paradigm method of image processing which has value in both academic and industrial purposes like video surveillance, criminal investigation, remote sensing, medical image processing, and consumer electronics.

Two main solutions are planned to improve the channel-by-channel or band-by-band approach. The first strategy proposes to transform the original image into a less correlated color or band space, which helps to perform denoising in each transformed channel or band independently. The representative work is the color BM3D. For better use of spectral correlation, the second strategy mutually characterizes the RGB channels or bands. These methods are generally considered with different priors and equalizations. t-SVD conserves the spatial information. The predefined FFT transform make it less sensitive to noise variation. The difficulty in the mathematical process of CBM3D, 4DHOSVD and the proposed MSt-SVD are juxtaposed.

C. Visual Evaluation

The ground real images of this dataset is not available. Therefore, we opt one severely corrupted image that contains lines, smooth regions, color texture and details. The input noise level σ of MSt- SVD[1] and CBM3D is modulated to get the best possible visual effects, and about σ = 50 is used for both MSt-SVD and CBM3D. Moreover, the parameters of commercial software Neat Image are carefully chosen to distinguish their difference. Neat Image presents the best results in terms of line areas, while MSt-SVD produces sharper details with invariable colour distribution. The benchmark CBM3D with predefined transforms tries to find an equilibrium between its features and smoothness.

All methods are modulated to generate their best average results. In practical application, however, Gaussian noise input, σ should be modulated for each image, so to better understand the effectiveness of state-of-the-art CBM3D, the best result of CBM3D on each image is reported, and this execution is named as 'CBM3D best'. PSNR and SSIM indices are used for objective evaluation.

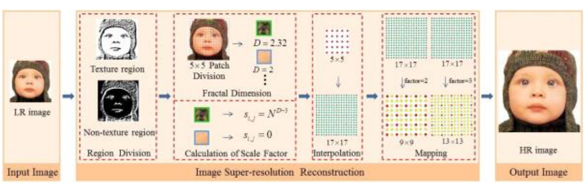

Fig. 1. Rational fractal interpolation algorithm


Fig. 2. Experimental result-noisy and neat image

3. Conclusion

The SR imaging has been one of the basic image processing research areas to provide a clearer image with a well-off and elucidative content. Hence, we propose a wavelet based super-resolution technique, using the interpolative methods. It will be based on scanty representation property of the wavelets. Finally, a HR image is acquired by pixel mapping. We construct the relationship among state-of the-art transforms with block diagonal representation, and investigate the proper choice of patch level transform for attaining denoising. Two simple and powerful methods that combine a global t-SVD basis and local PCA transform are proposed.

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