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Comparison Analysis of a New Color HOSVD & Varies De-Noising Filtering Technique for the 'Lena' Image Corrupted by Pepper & Salt Noise

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***Abstract*— In this work, we propose a very superior and elegant patch-based, machine learning technique for image de-noising using the higher order singular value decomposition (HOSVD). The method simply groups together similar patches from a noisy image (with similarity defined by a statistically motivated criterion) into a 3D stack, computes the HOSVD coefficients of this stack, manipulates these coefficients by hard thresholding, and inverts the HOSVD transform to produce the final de-noised image. Our method chooses all required parameters in a principled way, relating them to the noise model. We also discuss our motivation for adopting the HOSVD as an appropriate transform for image de-noising. We practically demonstrate the better performance of the method on color images. On color images, our method produces state-of-the-art results, outperforming other color image de-noising algorithms at moderately high noise levels. A criterion for optimal patch-size selection and noise variance estimation from the residual images (after de-noising) is also presented. And also using varies filter VMF, VDF, DDF .our main Moto is comparing the both method HOSVD and varies de-noising method.**

Keyword-*Image De-Noising, Singular Value Decomposition (SVD), Higher Order Singular Value Decomposition (HOSVD), Varies De-Noising Method, Patch Similarity***

I. INTRODUCTION

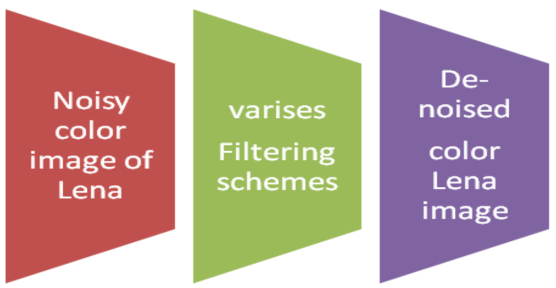

Fig1.1. Filtering algorithms for image noise cancellation

(A)Varies filtering method

(i) Vector Median Based Filters:- in this method all the pixels in the filtering window are considered as vectors. In the first step for each vector compute the distances to all other vectors.

$$\varphi_1 = \sum_{j=1}^{N} \|X_i - X_j\|, i = 1 \ldots\ldots, N$$

Where N is the total number of pixels in the window. The main drawback of this filter is that it takes into consideration only intensity of the vectors [5]. Some different method are give as adaptive VMF, weight VDF, etc.,[6-9].

In an analysis approach, vector angles are as a distance measure and the resulting filter is termed as basic vector directional (BVDF) [10]. Here the aggregated angles are given by,

$$\theta_i = \sum_{j=1}^{N} \theta(X_i, X_j), \qquad i = 1, \ldots\ldots\ldots\ldots \theta(X_i, X_j)$$

$$\theta_i = \cos^{-1}\left(\frac{X_i, X_j}{\|X_i\| \|X_j\|}\right)$$

The main drawback of this filter is that it takes into the consideration only the hue (angle) of the vectors. A variant of this filter is generalized vector directional filter (GVDF) [8], where a set of vectors having smaller aggregated angles than other vector in the window is obtained as opposed to BVDF in which we get a single vector whose aggregated angle with all other vectors is minimum. Then this set of vectors is used to generate the filtered value according to their intensity. Thus, the GVDF split the color image processing into directional processing and magnitude processing [11].

$$\theta(X_i, X_j) = \cos^{-1}\left(\frac{X_i, X_j}{\|X_i\| \|X_j\|}\right)$$

.

To improve the performance, VMF and VDF are combined to form a new filter called directional filter (DDF)[12].in distance measure is given by,

$\varphi_{i=s_i^{1-p} s_i^{p}}, \ p = \{0,1\} \ and \ i = 1 \ldots \ldots . N$

To avoid excessive smoothing, switching based colour filters are used in which every pixel is first tested for noise and if found noisy, is replace by the output of a vector filter [13-15]. One such scheme is given in [16]. To identify the noisy pixel, four 5x5 Laplacian kernels are used. Furthermore, instead of gray value and another switching strategy, the difference between accumulated sum of angles for central pixel and average accumulated sum.

(B) Resolution Enhancement on HOSVD basis:

Let, $f(x), x = (x_1, x_2, x_3)^T$ represent the image function x_1 and x_2 correspond to the vertical and horizontal coordinates of the pixel, respectively. x_3 Is related to the color components of the pixel, i.e. the red, green and $f(x)$ can be Approximated (based on notes discussed in the previous section) in the following way:

$$f(x) = \sum_{k_1=1}^{I_1} \sum_{k_2=1}^{I_2} \sum_{k_3=1}^{I_3} \alpha_{k_1,k_2,k_3} \overrightarrow{\omega_1} k_1(x_1). \overrightarrow{\omega_2}, k_2(x_2). \overrightarrow{\omega_3}, k_3(x_3).$$

The red, green, and blue color components of pixels can be stored in a m×n×3 tensor, where n and m correspond to the width and height of image, respectively. Let denote this tensor. The first step is to reconstruct the functions
$\tilde{\omega}_n, k_n$ $1 \le n \le 3, 1 \ll k_n \ll I_n$ based on the HOSVD of tensor as follows:

$$\beta = D \otimes_{n=1}^{3} U^{(n)}$$

Where, D is the so called core tensor. Vectors corresponding to the columns of matrices $U^{(n)}, 1 \le 3$ as described in the previous section are representing the discredited from of function $\tilde{\omega}_n, k_n(x_n)$ corresponding to the appropriate dimension $n, 1 \le n \le 3$.

Our aim is to demonstrate the effectiveness of image scaling in the HOSVD based domain.

Let $s \in \{1, 2, \ldots\}$ denote the number of pixels having to be injected between each neighboring pixel pairing horizontal and vertical directions. First , let us consider the first column $U_1^{(1)}$ of matrix $U^{(1)}$ based on the previous sections, it can be seen, that the value $\tilde{\omega}_{1,1}(2)$ to the 2nd elements …. $\tilde{\omega}_{1,1}(M_n)$ to the
$M_n^1 th$ element of $U_1^{(1)}$. To scale the image in the HOSVD-based domain, the $U^{(i)}, i = 1..2$ matrices should be updated, depending on s, as follows: the number of columns remains the same, the number of columns remains the same, the number of line will be extended according to the factor s. Let us denote the such obtained matrix as V^1 For example consider the column $U_1^{(1)}$ of $U^{(1)}$. the elements of $V_1^{(1)}$ are determined as follows:

$V_1^{(1)}(1) := U_1^{(1)}(1), V_1^{(1)}(s+2) := U_1^{(1)}(2),$
$V_1^{(1)}(2s+3) := U_1^{(1)}(3), \ldots, V_1^{(1)}((M_n - 1)s + M_n) :=$

$U_1^{(1)}(M_n)$ l, .

The missing element of $V_1^{(1)}$ can be determined by interpolation. In the paper the cubic spline interpolation was applied. The remaining columns should be processed similarly. After every matrix element has been determined the enlarged image can be obtained using the question (20)

To judge the filtering performance of the proposed scheme, four, 24-bit, RGB color test images namely 'Lena', each of size 512 x 512, are used. These test images are filtered by the proposed filtering scheme as well as several other conventional and recently developed schemes. The filtering results as well as several other conventional and recently developed schemes. The filtering results in terms of PSNR are given in Table for various models used in the study.

We have also observed that if the proposed detection method is followed by component wise filtering then the PSNR in the filtered image inceases at the cost of NCD and is highest among all the schemes considered in the study. However, the true worth of a color filter is shown by the NCD that it can Achieve and the proposed color filter achieves a significant reduction in the NCD value at the time maintaining a good PSNR which is comparable to that shown by other schemes like as VMF, VDM, DDF, and HOSVD.
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III RESULTS


Original Image


Noise Image


VMF Image


VDF image

DDF image

Proposed HOSVD image

Fig.1.1 varies de-noising proposed method

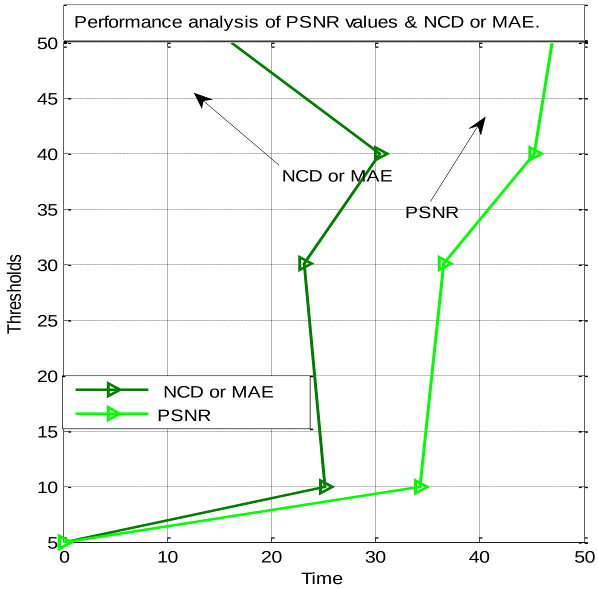

Fig.2. graph plot of PSNR values & NCD or MAE

IV-CONCLUSION:

In this work, the image noise cancellation is main Moto our work and comparing the result of stat of art method. The quality of the image noise cancellation depends on the two major factors: the techniques for image noise cancellation in color images are categories two classes. first component-wise methods and second vector method .The performance of the adaptive HOSVD,, color image noise cancellation techniques is good compared to other VHF, VDF, DDF, HOSVD, method in terms of PSNR between de-noised image and original image. Hence, from these results it can be concluded that the HOSVD image noise cancellation techniques is more efficient for suppression of color noisy image with pepper & salt noise than others. Thus the image after color image noise cancellation of Lena image has a better visual quality image. The simulation performed on the noise image Lena with a dimension of 512x512 with an SNR 0dB shows that this approach can achieve the PSNR'S of VMF, VDF, DDF, HOSVD is 32.2, 36, 6,40.1 and 46.9, respectively. And minimizes the CND's of VMF, VDF, DDF, HOSVD is 25.2, 23.1, 30.2, and 16.2, respectively. Fig.2. graph plot of PSNR values results & NCD or MAE is more practically on MATLAB.

Method	PSNR	NCD Or MAE
VMF	34.2	25.2
VDF	36.6	23.1
DDF	40.1	30.2
HOSVD	**46.9**	**16.2**

Table 1.1 of varies adaptive filtering techniques for Lena color image.

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