Evaluation of patch based image processing for image enhancement

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Abstract— The objective of image enhancement is to process the image so that the result is more suitable to the for use of the image.. Image enhancement is a field that is being used in different areas and discipline as well. Recent advances in the field of information technology and signal processing have invented new horizons to digital image processing, design and implementation of various new innovative approaches. This paper involves the use of patch based approach that may in capacity to behave as better approach. In proposed patch based approach we are classifying the patches basically corrupted patches into two or more than two groups based on their Euclidian distances which discovers the patches after applying different permutations to these corrupted patches. The resultant patches are now arranged so that we expect smooth image for applications. Patch based enhancement of image is an application of patch in the area of feature extraction for enhancement of a image. The images will be used for patch based and noisy patches will be rearranged and image will be enhanced in the features we desire

Index Terms— Patch based processing, Eclidian Distances, Shortest path , permutation matrix, denoising.

1 Introduction

In the field of image processing, use of patches is not only simple and popular also results in effective approach to the proposed work. Let this processing of patches be applicable to enhance the image features like quality , colour intensity etc. There are exuberant challenges in enhancement of the image. Instead of processing on the whole image at once, we propose a simple approach of segregating the image into patches and then applying image processing to enhance its features. In the field of filtering a particular image there are lot of filtering approaches i.e. gabor filtering, erosion dilogen technquies are available. Which will be made simple and easy when we workout with small element of the image that is patch. The Patch extracted from corrupted image have similar patch that exists from the same image.[1] The size of patch is very low if we compare this with whole image (specifically size of patch will be 8x8 pixels). By applying patch based processing it is possible to enhance the given corrupted image efficiently as shown [2] – [8] . The processing of these patches will be done through extraction of these patches and then rearranging them according to the euclidian distances between the patches. The processed resultant patches will be kept into the original corrupted image to reform enhanced smooth image.

There are different ways to interrelate the patches with each other one can arrange these patches as example NL means algorithm which involves weighted average of pixels with similar surroundings, clustering of patches and treat each set separately by using representative dictionary, using sparse representation of patches or pixels collecting the patches[2] – [4] with similar properties in to a group perform sparsification on these groups[5] – [8].

A common approach for this is to have every patch from image may find similar to extracted patches. A joint treatment of patches supports reconstruction process by applying non local force thus enables better enhancement .

In this paper we have adopted the core idea of reordering of patches. Firstly we extract all possible overlapped patches. Their spatial relationship is discarded and finding the completely new way to reorganize themselves. All the patches processed are rearranged by shortest possible path solved with the help of travelling sales man problem. Highlighted assumption for this proposed work is proximity between two patches implies to proximity between their centre pixels. Which helps to achieve enhanced image quality. Proposed approach is also suggest rearranging the corrupted patches to what to would be regular signal.

Our major aim to enhance the images in the field of Image processing. Images in various applications pose a great problem since the image features are not distinguishable, due to wide variety of features such as colors and mixed complexity
We carry out our work as follows:

1. We will take real image.
2. We will enhance image based on patch based image processing.
3. For this we have applied different permutations of staked version of the patch.
4. Patch of image will be passed to patch reordering approach.
5. Resultant patches then applied for inverse permutations.
6. Thus every patch on image will be processed using patch based approach and hence output picture will enhance the features of image.

2 LITRATURE SURVEY

Much work regarding image processing was done in reordering of the patches. The working principles out of these are almost same.

NL – Means algorithms:

In this method image is converted into patches and then any random pixel is considered for starting of processing. Then weighted patches are arranged as per similar distances.

Clustering of Patches Approach:

In this approach patches with similarities were grouped into clusters and treated disjoint sets and each set is treated separately. First the set of pixel is processed then second set of pixel is taken into consideration for processing and so on till all pixels are processed.

Sparcifying global transform:

In this approach image is taken as set of patches. Then patches represented in representative dictionary (dictionary based) for patches. Then representation format is used for sparsely represent them,which inturn results into reordering structures.

Patch based image processing approach

In this approach uses adaptive wavelet transform is constructed which is followed by sparsely represent given image. Patches are operated on permuted order , which is drawn from shortest path.

In other work of the authors Idan Ram, Michael Elad proposed new scheme [1] which traced out same core idea of patch ordering. In prior work i.e. In wavelet decomposition [2] – [3] scheme, it follows level wise approach where a permutation is derived from the tree. Results in denoising of given image similar to those obtained with the K-SVD algorithm [6]. The use of proposed scheme gives better results than K-SVD and BM3D [7] algorithm which are used for average to high noise level, and high noise level respectively. In previous works authors proposed different patch based approaches. They have introduced the image adaptive wavelet transforms which are follower to sparse representation of image. The improvement in this work by the other is done in the form that they have eliminate multiscale approach and sparsity driven process. In said work they have only focussed on patches reordering. system that classify the extracted patches that are expected to process i.e. noisy pixel or missing pixel into more than two groups which in turn increase number of patches for process which will surely results into better quality of the image than previous one .

Above approaches are compared and summarized as follows

TABLE 1
COMPARISON OF VARIOUS APPROACHES

Approach	Drawback
NL – Means	It causes performance for large images
Clustering based Approach	Complexcity to implementation Scalability issues
Sparse representation Approach	Leads to complexicity in implementation & dictionary

3 PROPOSED SYSTEM

System flow is explained in further sections.

3.1 System Process Flow:

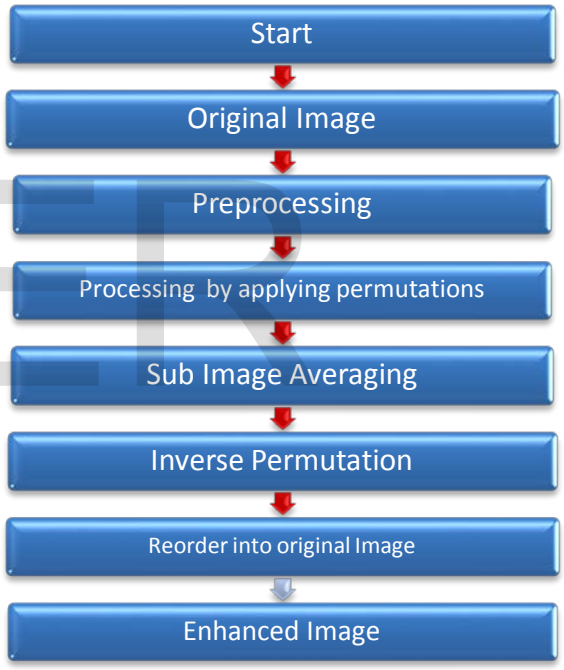


Fig. 1. Flow of the system

Figure 1 shows the modules used in proposed system The system module consists of six sub modules,

In first sub module load the image processing.

Preprocessing :

Preprocessing is term for operation on image at first level of abstraction. By applying preprocessing one can suppress undesired distortions or enhances some features. Preprocessing involves resizing image, dividation of image into 8 X 8 pixels (patch formation)

Construct the staked version of input image. The staked version is nothing but the patches which we extracted for processing has some value that is to be represent in matrix form

then it will processed for all subimages. After processing all patches i.e. to be considered as subimage.The smooth ordering is nothing but the heart of the system in this module the feature of the image by simply permuting the x with P, which is result of number of permutations applied on patches. Then applying pre knowledge or ordering theory of the distances i.e. ecludian distances among the patches. We rearrange the patches to gain the quality of the image. The image exporter will transform the selected modified patch that is to be most suitable as resultant sub image. And finally we average the sub images i.e. intermediate results to obtain final fine quality image.

3.2 The Basic Scheme

Consider the image X of size M1 X M2 as input and the corrupted version of this image (X) will be K. which contains noise or may have pixels missing in input image. Or we may refer this image as question image. Also the staked versions of X & K will be x and k respectively. Then corrupted image will be

$$k = Px + c \qquad (1)$$

i.e. staked version of corrupted image must satisfy above equation . in equation (1) P is the matrix of order M X M which is known as corruption factor. c will be additive white Gaussian noise independent of x. Actually we are performing permutations on pixels in image.

The main goal of this scheme is to rebuild x from k to make this simple we have applying permutation matrix T of order M X M. for each patch we are applying the permutation to get different values for x which likely to produce smooth signal. Also applying T to k and retaining the different values of k^T. Using basic knowledge we then considering one dimensional smoothing operator i.e. S on k^T . (one dimensional operations are referred as filtering or interpolation) then we rebuild the image by performing inverse permutation T^{-1} .

$$\hat{x} = T^{-1} S\{T_k\} \qquad (2)$$

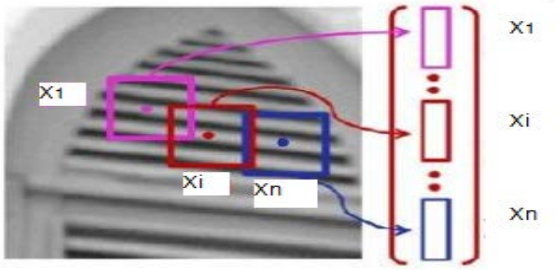


Fig. 2. Patch extraction & column stake Formation

3.3 Algorithm for proposed work:

This algorithm is used for reordering of the patches

Initialization : choose a random indexj and set
$\Omega(1) = \{1\}$
Main iteration : perform following steps k=1, …… N-1

1. Set A_k to be set of indices of M X M patches aroundx_{Ω_k}
2. $|A_k / \Omega| = 1$ then set Ω (k+1) to be A_k / Ω
   Else if
   Else if $A_k >= 2$
   Find x_{j1} – nearest neighbor to $x_{\Omega(k)}$
   such that $j_1 \in A_k$ and j_1 not $\in A_k$
   Find x_{j2} the second nearest to $x_{\Omega k}$
   such that $j_2 \in A_k$ and j_2 not $\in A_k$
   Else if $A_k / \Omega == 0$ find X_{j1} – the nearest neighbor to
   $x_{\Omega k}$ such that j_1 not $\in \Omega$
   Find x_{j2} – the nearest neighbor to x_k such that j_2 not $\in \Omega$
   set $\Omega(k+1)$ to be {j1} with probability
   P1 α exp [-w($x_{\Omega k}$,x_{j1} / €]
   {j2} with probability
   P2 = 1-p1 α exp [-w($x_{\Omega k}$,x_{j1} / €]

Output : The output set holds proposed ordering.

3.4 Sub image Averaging

The corrupted image patch (noisy or overlapped patches). In proposed system, patches extracted in column by column order. The permutation matrix T is derived such that it will gain middle point of the pixel as the assumption is every patch is associated only with its middle pixel. For each staked version (vector) of image be c are the part of corrupted image K.. the extractor module extract the patch from staked version of given corrupted image i.e. E_i which is the matrix of order M_p X M where $M_p = (M_1 - \sqrt{m} + 1)(M_2 - \sqrt{m} + 1)$. The Ei
Matrix is used to extract the ith subimage from column staked version of corrupted image and then we apply smoothing factor S and rearrange the subimage order by inverse transform to regain subimage

$$\hat{x}_i = T^{-1} S\{T k_i\} = T^{-1} S\{TE_i k\} \qquad (3)$$

This will regain single subimage, if we follow same approach (cycle spinning) for all extracted subimages and reconstruct an image will gives us averaging of image from subimage.
Intermediate reconstructed subimages are as follows

$$\hat{x} = F^{-1} \sum_{i=1}^{n} E_i^H \, \overline{\overline{x_i}} \qquad (4)$$

Where F is diagonal matrix of order M X M and E_i^H is the matrix that reinserts the ith subimage in original palce of the patch. i.e.

$$F = \sum_{i=1}^{n} E_i^H E_i \qquad (5)$$

and when we apply this approach by using k random permutations S_k we get the final reconstructed image by averaging

the intermediate results with various permutations

$$\hat{x} = \frac{1}{K} \sum_{i=1}^{n} (F^{-1} \sum_{i=1}^{n} (E_i^H T_i^{-1} S \{ T_k E_i x\} \qquad (6)$$

For each corrupted patch we have new patch after processing and which provides us new values for our results. Now these patches are reinserted into given corrupted image by reorder of the patches based on the distances.

4 EXPERIMENTAL RESULTS

4.1 Image denoising

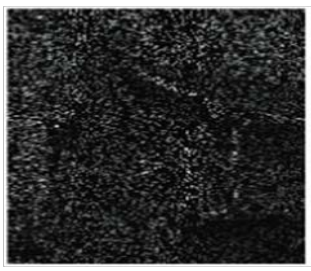
In this case input is corrupted image which may have noise, overlaps of pixels etc.The aim is retrieving the image feature like clarity , quality from this input image. The results for proposed scheme are computed by following two approaches first one is without classifying the patches to be processe& patches to be processed in to two or more than two groups as shown in table:

TABLE 2
RESULTS FOR DENOISING (PSNR IN DB)

Image	Patch re-ordering	Proposed Approach	Proposed Approach
Leena	28.4	29.2	30.5
Tower	31.6	32.6	32.9
Human Face	29.5	31.1	32.8
Barbara	29.6	32.5	35.9

4.1 Image inpainting

The case of image inpainting means recovery of missing pixels in the given corrupted image. We handle this case by assuming that there is no additive noise, therefore c = 0, and P is a diagonal matrix of size M × M which contains ones and zeroes in its main diagonal corresponding to existing and missing pixels. In case each patch may contain missing pixels . We choose the distance measure between patches ki and kj to be the average of squared differences between existing pixels that share the same location in both patches We start by calculating the matrix T according to the scheme described We demonstrate the performance of our proposed scheme on corrupted versions of the images Lena, obtained by 80% of their pixels are missing, we have compare results and performance of our algorithm to other patch-based algorithms.



PSNR = 6.22dB PSNR =32.76 dB

5 CONCLUSION

The proposed work for image processing scheme based on one dimensional patch ordering of pixels, to retrieve the image quality.We have try to show using different permutation matrices and application of smoothing operations the proposed work will gives better quality image even image consisting high noise or missing pixels.

There is large future scope in the area of image processing to extend this work that we are considering. The use of distances between patches and classification. But if one can develop the scheme to perform this task by optimisation of the number of nodes visited even by using number of groupings. Also this approach can also be implemented for 3D images to improve the quality of 3D images or models.

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