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An Efficient Method for Restoration of Blurred Image Using Segmentation Algorithm and Blind Image De-convolution Technique

Pooja Bajpai, Mr. Sharad Kumar Gupta

***Abstract*— In imaging science, image processing is a form of signal processing in which input is an image and output is either an image or characteristic or set of parameters related to image.**

Image restoration is the process of restoring or de-blurring an image which has been undergone certain degradations. We proposed a method for image restoration based on segmentation and fuzzy clustering. Image restoration is the process of restoring the original image from the observed image that can be degraded or blurred by some external sources. This proposed method firstly partition the image into specified segments and then it will use fuzzy clustering to cluster the segment based on their PSNR value and provide the segments that needs to restore which will further used for accuracy of method. The performance of the system is evaluated on the basis of PSNR value.

***Index Terms*— Image Restoration, Image Deblurring, Segmentation, Fuzzy Logic, PSNR value.**

I. INTRODUCTION

In today's world, an image defined is considered to be a function of two real variables, for example, I(x, y) with I as the amplitude (e.g. brightness, contrast) of the image at the coordinate position (x, y) where x and y are two coordinates in horizontally and vertically. In imaging science, image processing is a form of signal processing in which input is an image and output is either an image or characteristic or set of parameters related to image. Image processing can be further divided into analog image processing and digital image processing. Analog image processing comes into existence which is operated on analog signals. An analog image can be mathematically represented as a continuous range of values representing position and intensity. Digital image processing has dominated analog image processing because of its useful properties like flexibility, reliability, easy manipulation, least expensive, compatibility. The digital image has better contrast and color than an analog image.

Image restoration is the process of restoring the original image from the observed image that can be degraded or blurred by some external sources. In image restoration, the main emphasis is to obtaining a deblurred image from a corresponding blurred one. There are numbers of factors that are responsible for blurring in the image like atmospheric turbulence, bad focus and motion between camera and original image. Generally when intensity of an image point is spread over several pixels, it goes blurred. This blurring is defined by a well-known operator called Point Spread Function (PSF) [1, 3]. Generally blur in the image is not uniform over an entire image. The amount of blur is different in different directions. The maximum amount of blur in the image is at the center of the image. So it is necessary to deblur the center part of an image compared to corner segments [2].

Pooja Bajpai, Electronics and Communication Engineering, M.Tech Scholar, Maharana Pratap Engineering College, Kanpur, India

Mr. Sharad Kumar Gupta, Electronics and Communication Engineering, Associate Professor, Maharana Pratap Engineering College, Kanpur, India.

II. RELATED WORK

In past decays, several techniques for image restoration are proposed. Each technique restores the image having different type of blur. Some techniques restore the Gaussian blur, some restore the motion blur and some restore the out of focus blur. In 2007 [4], Mohsen Ebrahimi Moghaddam proposed a technique to estimate the out of focus blur. This method is based on a mathematical model. In 2009 [5], Feng, Jun and Hong proposed a restoration method based on PSF estimation.

In this paper, they concentrated on Gaussian blur in images. They estimated PSF for the Gaussian blur parameter. In 2009 [6], Rajeev Srivastava and D. Roy proposed a technique which was based on the motion blur estimation by using PDE's equations. In 2009 again [7], Sun Shaojie and Li proposed a method for single blurred image due to camera shake. In 2012 [12], Ms.S.Ramya and Ms.T. Mercy Christial proposed a blind deconvolution algoritm for restoration of gaussian blurred images.In 2013 [9], Kishore Bhagat and Puran Gourproposed a method for the estimation of motion blur parameters. All these proposed techniques are used for image restoration but the common property of all these restoration techniques is that it considers the whole image and then applying the algorithm for deblurring. This is not the case always. Sometimes we need to deblur only some portions or segments of the image by which the time complexity of image restoration system has been reduced. In 2013 [13], Jiangyong Duan, Gaofeng Meng, Shiming Xiang and Chunhong Pan proposed a method for image restoration which wasbased on finding the similar image pairs by applying SIFT (Shift Invariant Feature Transform). After extracting the similar image pairs, they estimated the blur kernel for restoring the image. Through this paper, we are going to propose a new method which is based on segmentation and fuzzy clustering which extract common feature corresponding to a blurred one. This method will identify those segments that need to be deblurring with the help of fuzzy clustering.

III. PROPOSED METHOD

The overall architecture of proposed Method is shown in the Figure 1, which demonstrate all the processing steps which are used.

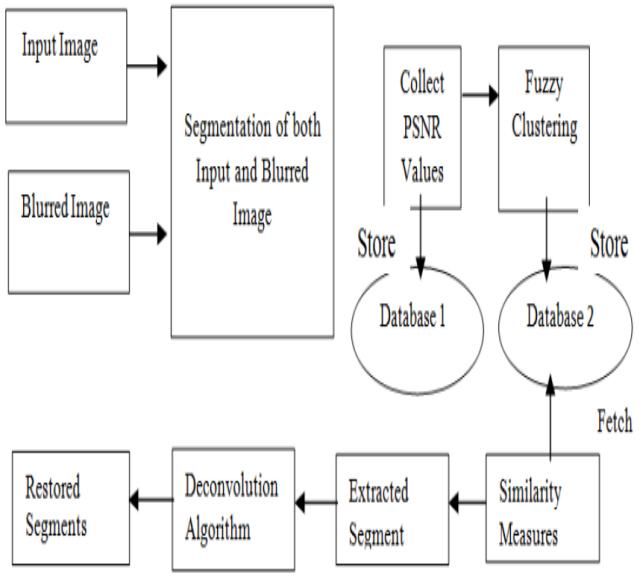


Figure 1 Architecture of Proposed System

Following steps are used in proposed method.

1. Read the input image I and blurred image B.
2. Convert the image from RGB to Gray, if they are in RGB.
3. Segment both the images using segmentation algorithm and calculate the PSNR values.
4. Store all the segments and their PSNR values of input image and blurred image in therespective database.
5. Find appropiate clusters using fuzzy algorithm.
6. Extract blurred segments i.e. features from the databse by applying the suitable similarity measurement.
7. Apply the deconvolution algorithm to restore the blurred segment.

IV. Image Segmentation

Image segmentation is the process of segment the image into several parts that can be used to extract useful information form an image. Image segmentation is very versatile research area in the field of image processing. In 2007 [10], Hassan Mahmoud, Francesco Masulli and Stefano Rovetta proposed segmentation based registration of medical images. In this paper, we utilize the property of image segmentation to find the segments which needs to be deblurred. The amount of blur is not scattered uniformly in any blur images. It is found maximum at the center and minimum at the corners. It may be possible that an image is partially blurred. In that case, we do not need to deblur the whole image. Instead of deblurring whole image, we have to deblur only those portions of image which have blurred commonly.

For extracting similar blur regions we have to apply image segmentation. After that we will divide both the input and blurred image into desired number of segments. For our method, we are dividing our both image into 16 segments. Number of segments depend on the image size. If the number of segments is not according to size of image then it will increase the time complexity of image. On the other hand, we will unable to visualize the image.

V. Fuzzy Based Clustering

Clustering process provides a way to cluster a dataset into different sub-clusters based on their common property. Clustering algorithms can provide a better organization for the maintenance and retrieval of multidimensional data. Clustering algorithm follows the nearest neighbor search algorithm for creating the clusters or classes. The elements in the same class exhibit the same property. In each class, different similarity measures are used to decide

Which member belongs to the corresponding class. During the literature, Ebrahimi Moghaddam and Mansour Jamzad 2007 [11] proposed a method which used fuzzy logic for identification of motion blur parameter. In fuzzy based clustering, each element belongs to acluster and associated with a set of membership levels. The membership value of each element belongs to a specific class in fuzzy based clustering. In the proposed method, Fuzzy based clustering is applied on PSNR values which were calculated through the segmentation algorithm. Each PSNR value corresponds to a fuzzy class and represents by a set of membership levels. Figure 2 shows the basic architecture of our fuzzy based clustering algorithm which is applied on PSNR values and shows the five basic membership level *i.e.*, Very low PSNR, Low PSNR, Medium PSNR, High PSNR, and Very high PSNR.

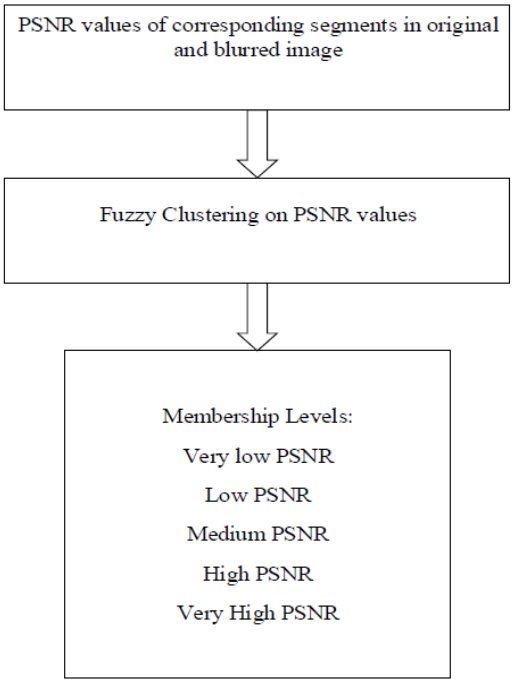


Figure 2 Fuzzy Clustering on PSNR Values

VI. Image Deblurring

Image deblurring is the process of restoring the image which has undergone certain degradation. In recent era, the image restoration algorithm had applied on the whole image. If the image is partially blurred then this approach will failed abruptly. In this section, we emphasizes on the restoration of segments of a blurred image rather than the whole image. Firstly we extract the segments of a blurred image which needs to be deblurred. Segments are extracted on the basis of membership levels of PSNR values which we calculated in the fuzzy based clustering algorithm. We will consider those segments which have the membership values of PSNR into first three membership levels *i.e.*, Very low PSNR, Low

PSNR, Medium PSNR. After that we extract the segments whose PSNR membership values falls into those three levels.

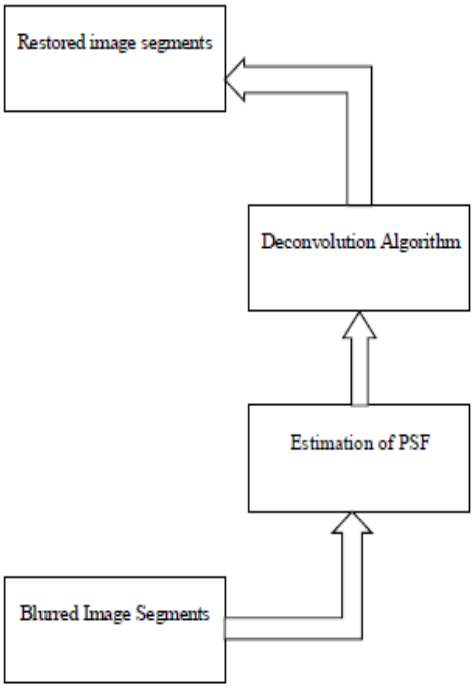


Figure 3 Deblurring Process

VII. Performance Evaluation

The evaluation of restored image is a crucial situation in the image restoration system. Several different methods for performance evaluation is used by the researchers. The most common and popular method which is used for evaluation of restored image is peak signal-to-noise ratio (PSNR). The better the PSNR value, the better the image. PSNR is defined by the Mean Square Error (MSE) and MSE is defined as

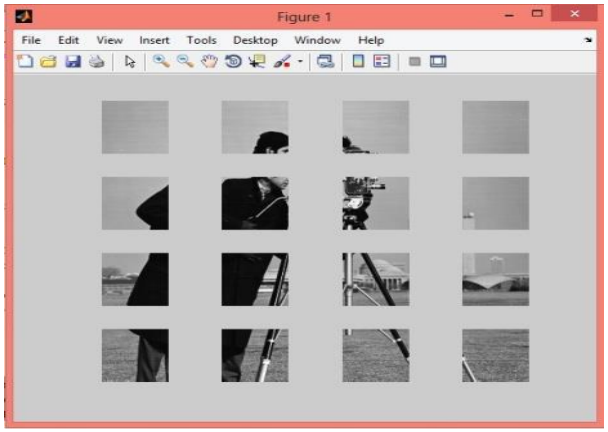
$$\text{MSE} = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

PSNR is defined as:

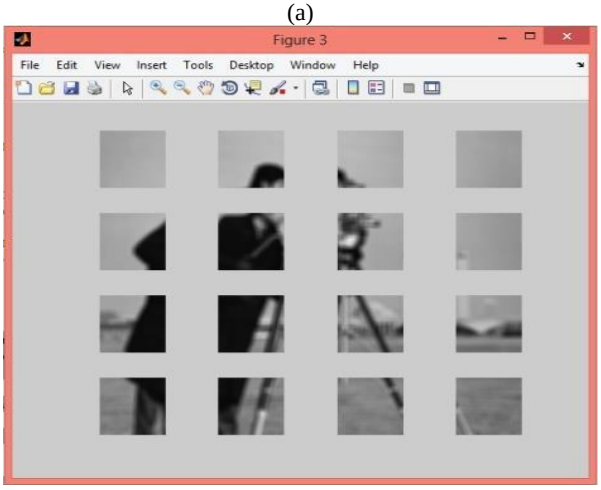
$$PSNR = 10\log_{10}\left(\frac{\text{MAX}_I^2}{MSE}\right)$$

Apart from it the performance of propsed system is calculated on the basis of number of segments extracted. The lesser the segments extracted, the lesser the time it takes to compute the restored image.

We simulated our proposed method in the MATLAB version 2013a. There are several standard images in the MATLAB toolbox. We took one of those standard images to demonstrate our proposed method. We demonstrate our method on the "cameraman.tif" image which has resolution of 256x256. At first we applied segmentation algorithm on both input image and its corresponding blurred image. During segmentation, we assigned a name to each segment of input and blurred image, say I-11, I-12 and B-11 and B-12 respectively. Along with segmentation of both the images, we also calculated PSNR values between each corresponding segments and stored it in the database. The initial segments of original and blurred image are shown below in the Figure 4.



(a)



(b)

Figure 4 (a) Original Image (b) Blurred Image

After applying the segmentation algorithm and calculating the PSNR values between each segment of input and blurred image, we applied fuzzy based clustering on the calculated PSNR values for extracting blurred segments. This fuzzy based clustering form the different membership levels for each segments. We extract the blurred segments with the help of these membership levels by applying suitable similarity measurement. The extracted blurred segments are shown below in the Figure 5.

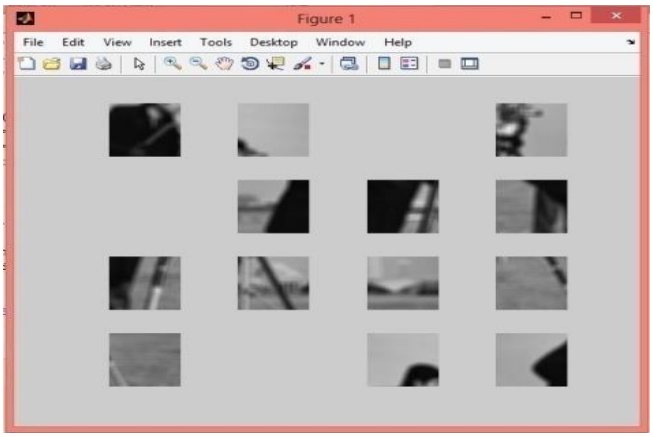


Figure 5 Extracted Segments for Deblurring

After extracting the blurred segments, Blind de-convolution algorithm is applied on these segments and their improved PSNR value is calculated. Figure 6 below shows the deblurred segments after applying the de-convolution algorithm.

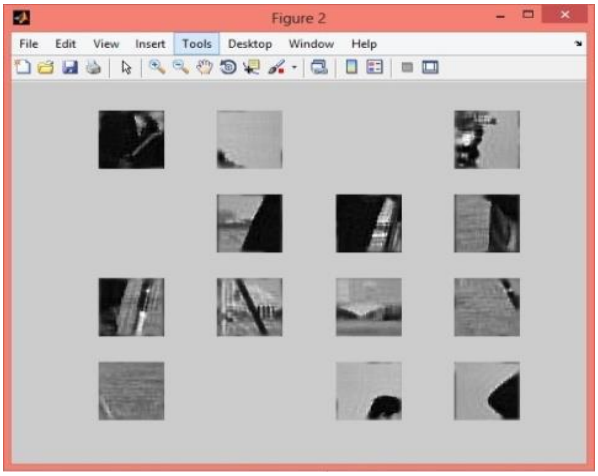


Figure 6 Deblurred Segments

Table 1 Result Comparison With Existing Method

Segment ID	Existing Method Result [13]	Proposed Method Result
B12	11.2379	14.5614
B13	13.5408	14.6057
B14	08.7906	11.9067
B21	13.5639	21.3572
B23	05.6691	09.8768
B31	12.6662	13.7231
B32	06.0541	09.2849
B33	11.4427	14.0649
B34	06.8948	10.8248
B41	05.3970	09.0276
B42	14.0385	15.9844
B43	09.4629	15.2675
B44	10.5226	18.2963

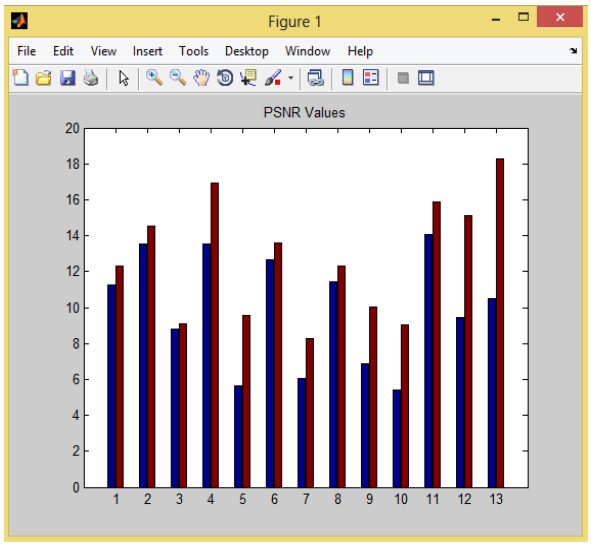


Figure 7 Comparison of PSNR values

VIII. Conclusion And Future Work

The main objective of the proposed method is to develop an image restoation system that works on the concept of feature matching. The proposed method is based on two steps. Firstly it segments both the input and blurred image and cluster those segments based on PSNR values. Secondly it retrieves segments having low PSNR values.

In proposed method, segmentation is used to find segments of the image that needs to be deblurred.Fuzzy based Clustering is used to reduce the number of segments for deblurring. The proposed method combines the segmentaion and fuzzy clustering with deconvolution method. This will increase the accuracy and efficiency of restoration system. This proposed method is better than other existing method for image restoration.

We just provided one way to utilize features of two similar image pairs for restoring the image. The more powerful algorithms can be developed in the future. As a future work, we can use another powerful deconvolution scheme to restore the image more accurately. We can also deal with the time complexity of the system which will increase when the number of segments will increase.

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Pooja Bajpai obtained her B.Tech from U.P Technical University, India. She is now a student of M.Tech (Electronics and Communication Engineering) in Maharana Pratap Engineering College, Kanpur, India.

Mr. Sharad Kumar Gupta is a working as Associate Professor and Head of Department of Electronics and Instrumentation Engineering, Maharana Pratap Engineering College, Kanpur, India.