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Research paper

Hybrid fuzzy and support vector machine based blur detection technique

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Abstract

The main objective of our research work is to acquire good quality of an image which is blurred. Therefore, in this research our effort is to propose an advanced algorithm to improve the quality of an image by eliminate the blur in an efficient manner. In this paper, two types of blurred images (i.e., Gaussian blur and out of focus) are used. Deblurring techniques are mostly used to eradicate the blur of an image using different methods & parameters. To reimburse blur different types of methods like algorithm, filtering techniques, fuzzy based approach, support vector machine are used. Blur detection methods are used to eradicate the blur from a blurred section of an image which is caused by the out of focus blur and Gaussian blur.

Keywords: *Fuzzy Approach; Gaussian Blur; Image Restoration; Out of Focus Blur; Support Vector Machine (SVM).*

1. Introduction

Image restoration in case of blurred images is most significant in an image processing. Blurring can be formed by various reasons ex. motion in camera. These days everyone is fond of capturing digital images [1]. Quality of some images are poor due to defocus, during transmission noise is added. So blurring corrupts the quali- ty of an image. Consequently, image restoration is the technology which is helpful for the blur eradication so to take out the degrada- tion to recover the image quality. Blur is a type of reduction in bandwidth of an image due to the damaged picture pattern process. When the image is formed, various causes occur for the image degradation. Long time taken by camera to capture the image will cause blur due to camera shake. When images are captured by a camera, the cause of blur of an image is due to temperature of sensor and light levels [2]. Another cause of image blurriness is transmission. So it is intricate to avoid blurriness of image in such conditions and it can degrade the image [3]. In an image processing, most commonly used blurring techniques are dis- cussed: Average Blur effect is used to remove the unwanted signal which is noise gets added during transmission through channel. Gaussian blur effect is used in graphics software, to minimize the effect of noise in image. It is used as an initial phase in vision algorithm with the aim to improve the structure of image at differ- ent scales [4]. Out of Focus Blur is used when there is a 2-D im- age plane and a camera descriptions a 3-D view on it, only some of the portion of scene is in focus. If camera aperture is round, the image at all the points are miniature disk, recognized as (COC) which is defined as the circle of confusion [5].
Blur occurs in an image in many different fields. Image blur representation is:

$$g(x,y) = f(x,y) * h(x,y) + w(x,y)$$

$$(value\ of\ \ x\ and\ y\ range\ is\ from 1 \ldots . M)$$

f considered as the ground truth image where g is the es- timation of original image, h is a blur point spread function, * denotes the convolution operator [6].
In linear deblurring technique [7], it is assumed that the process of blurring is linear. In number of cases the blur can be approximated by a linear model. Let's assume that the required sharp image S and the recorded blur image R are two gray scale digital images of size m × n. For this case, two matrices are taken A_e , A_h of m × m , n × n respectively.

$$R = A_e S A_h^T \quad (1)$$

$A_e S$ term represents applying the same vertical blurring opera- tion to all columns of S whereas $S A_h^T$ represents applying the same horizontal blurring to all rows of S. The solution to this lin- ear model is:

$$A_e^{-1} R (A_h^T)^{-1} \quad (2)$$

Here, the image that is constructed is the approximation image of the desire image as noise is eradicated. Image noise is a sort of imitation and unconnected information, so it is considered as:

$$R = A_e S A_h^T + I \quad (3)$$

Where I is image noise of m × n. The sharp image can be re- constructed by equation:

$$S = A_e^{-1} R (A_h^T)^{-1} - A_e^{-1} I (A_h^T)^{-1}$$

This term $A_e^{-1} I (A_h^T)^{-1}$ is known as inverted noise, or recon- struction of the sharp image.

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2. Literature review

A review of prior work carried out in the field of Image Deblurring Technique and the methodology put into practice to diminish their limitation is summarized as fol- lows: J.Singha [8] makes use of SVM based fuzzy filter employs impulse noise to eradicate from grayscale images. SVM is used for the impulse noise detection from images. Fuzzy filtering is carried out which is based on the outcome achieved throughout the testing phase. The recreation out- come suggests how this method works well for several state of art method although conserving structural similarity to a great extent. Dong Yang [9] presenting a restoration me- thod for corrupted image which is based on the technique of partial distorted regions recognition along with classifica- tion. Initially, blur in region detection algorithm is delibe- rated after segmentation to identify the distorted areas from the corrupted image, then a proficient classification method of distorted areas is specified to bring away the sorting of unclear regions, at last the kernel for blur in different group of the blurred areas is predictable. H. Lee [10] presents framework for blur section identification to sur- mount the insufficiency of conventional methods. Author proposes 3-way identification blur technique, which seg- ments an image into two categories i.e. non-blur and defo- cus blur, areas at once. G.R.Sinha [11] a colossal research involvement on image denoising techniques which are also the methods of image enhancement with the aim of actual- ly improve the preferred information and suppress unneces- sary section in a digital image. This paper presented a non- linear way for eradicating impulse noise, which is known as salt and pepper noise in grayscale images. The algorithm MFBDA [12] which is fuzzy based is used. A new method which is executed is better than earlier method and other is based on non-linear fuzzy image enhancement techniques. Muhammad Sharif [13] proposed filtering method that uses predictable noise variation through local and global statis- tics meant for the erection of a vigorous fuzzy membership function. Constructed fuzzy membership function allots suitable weights to the statistical approximate, which is based on the removal of noise and detail conservation capa- bility. Local and non-local fuzzy weighted estimators are used to restoration the noisy pixels. Comprehensive simula- tions are carried out, and restoration outcome are computed based on well-known performance actions. H. Kaur [14], proposed a image detection blurred structure for automatically detect distorted along with non-blurred sections of an image. Here proposes a novel approach for quality vector consist of the information for image region and for the blur kernel. Therefore it is named as kernel-specific feature vec- tor. Information that is take out from image area is based on blur pixel maximum saturation methods. Ayyaz Hussain
[15] a novel clustering method based on generally con- nected directional neighbours is offered to restrain low, also high-density of an impulse noise from images. Mainly con- nected neighbours demonstrate an imperative task in esti- mation as well as to restore the scale gray level of blurred pixels. Initially, the majority of directional neighbours [16] that connected pixels to pixels directly which is at the cen- tre. The directional pixels that is vertical, horizontal and diagonal which are close to next pixels in the window fur- ther processed are divided into two identical range clusters that are based on gradient standards. Sachin Suryan [17] proposed a new two-step filter, which uses a fuzzy detection and an iterative filtering algorithm, has been presented and the filter used by the author is especially developed for re- ducing all kinds of blur. Its main feature is that it leaves the pixels which are noise-free unchanged. Author used filtra- tion iterative filtering algorithm for noised and blur image detection is mostly covered. Future scope of this study could leads to improved and more robust filtration tech- niques. This techniques output is optimal restoration of de- graded image [18].Dong Yang [19] proposed a novel ap- proach to restoration method for image degradation which depends on partial distorted areas that is recognition and classification. Initially, the distort class is confirmed then estimation of the exact blur kernel parameters are used. They used algorithm which is based on frequency domain to approximate the blur kernel techniques. Later than the Total Variation based deblurring method is requied to reins- tate the regions that are blurred. In this algorithm, degraded image with partial blurred image is given as an input. Then blur detection is detected from an image and in next step classification is done. Blur is restored after classification. Then recombination of segmented images takes place. Final image is a restored image. Shengyang Dai[20] presented a paper, a two-layer picture model is examined. Based on the technique of partial blur process, a new recovery method was proposed for a particular input image. Foreground with background layers are recovered concurrently with the as- sist of the matting method.

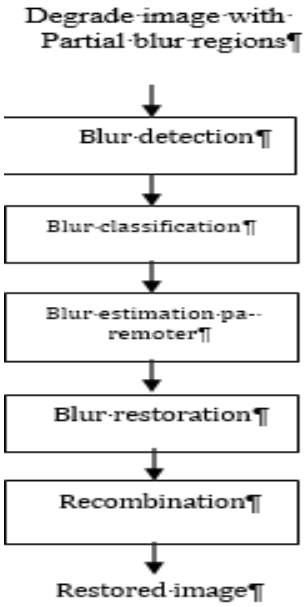


Fig. 1: The Flow Chart of Existing Technique.

3. Restoration approach based on blur detection and correction

i) The requirement of detection and correction of blurred Regions: Blurring is tumbling the contents of an image. It can be contemplation of as applying any filter to an image. There are number of filters that can be used for blurring. In order to do, ini- tially we have to detect which type of blur in an image. This issue can be resolve by the new algorithm of detection of blur. Conse- quent, we locate the blurred areas and require identifying which class of blur it is from, once it know the formation of the kernel of blur we get its class of blur. This matter can be sort by this new blur correction algorithm.

ii) The Image restoration scheme based on blurred areas

In case of blurred regions, fuzzy membership values are used to restore detection outcome. For blur correction, support vector machine is used. Then, we restore the blurred images which are depends on the approximate blur kernel by the use of proposed hybrid algorithm of fuzzy and support vector machine. Finally, we get the restored image with its reinstate method. The flowchart of hybrid fuzzy and support vector machine is shown Fig. 1.

4. Proposed methodology and results

On though, numerous Blur Detection techniques have been proposed so far but no one is effective for every case. Each technique suffers form decision making criteria i.e. which region is blur or not. To handle this issue, a new hybrid technique is proposed which will utilize fuzzy membership values for partially blurred regions and recognize them using support vector machine algorithm. Since fuzzy has better decision making and support vector machine reorganiza- tion rate. Therefore proposed recognition technique will provide better result than earlier techniques.

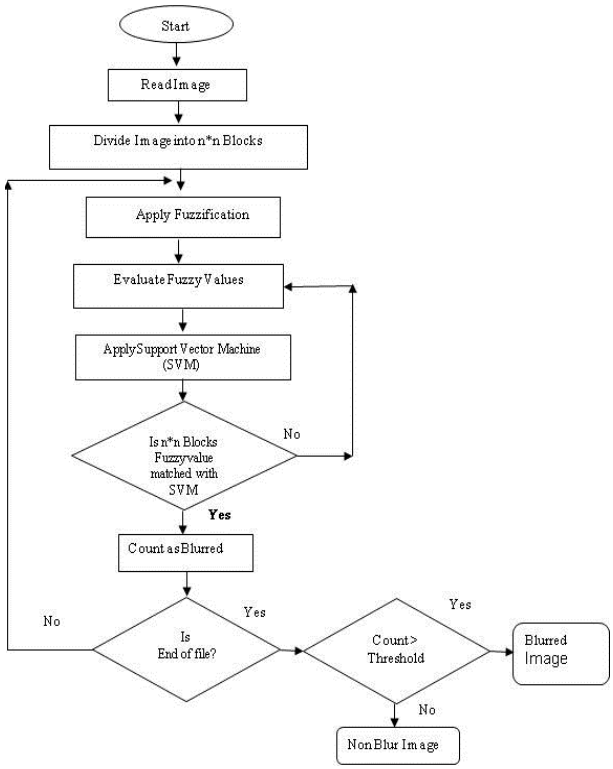


Fig. 2: The Flowchart of the Proposed Algorithm.

As shown in table 1 and table 2, results of Proposed Technique are better than existing Technique. It is clearly showing proposed technique works well on both types (Gaussian blur and out of focus) of blur showing in figure 2 and figure 3.

Table 1: Comparison of Gaussian Blur

Parameters	Existing	Proposed
Accuracy	68.89	69.51
Bit Error Rate	68.04	63.01
Sensitivity	37.75	38.07
Specificity	24.59	25.11
F-Measure	26.04	28.22

Table2: Comparison of Out of Focus Blur

Parameters	Existing	Proposed			
Accuracy	69.27	70.14			
Bit Error Rate	59.99	58.47			
Sensitivity	24.27	34.56	Specificity	12.80	13.67
			F-Measure	20.16	25.98

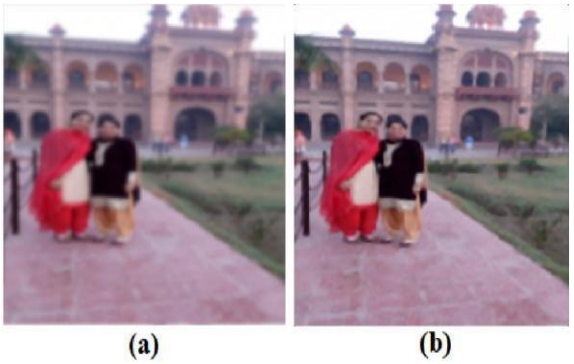


Fig. 3: Restoration Result of Gaussian Blur A) Input Image B) Restored Image.

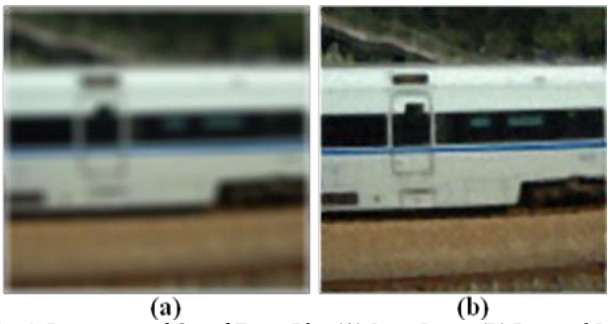


Fig. 4: Restoration of Out of Focus Blur (A) Input Image (B) Restored Image.

For experimentation and implementation the proposed technique is evaluated using MATLAB tool u2013a. Here we will compare the Gaussian blur and focus blur for image enhancement on the basis of various image quality evaluation parameters like Accuracy, Bit error rate, Specificity, Sensitivity and F-measure. The existing methodology give good results in enhancing the im- age but it neglects certain regions in image such as mixed region and also effect of blurring is not taken into consideration. The proposed approach gives efficient results in improving the blurri- ness of an image. The tabular and graphical comparison has been done between existing and proposed methodology on the basis of parameters Accuracy, Bit error rate, Specificity, Sensitivity and F- measure.

i) Accuracy can be defined as the difference between the input value and the mean of underlying process that generate the data. Higher value generates better results. Therefore, it can be calcu- lated as:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

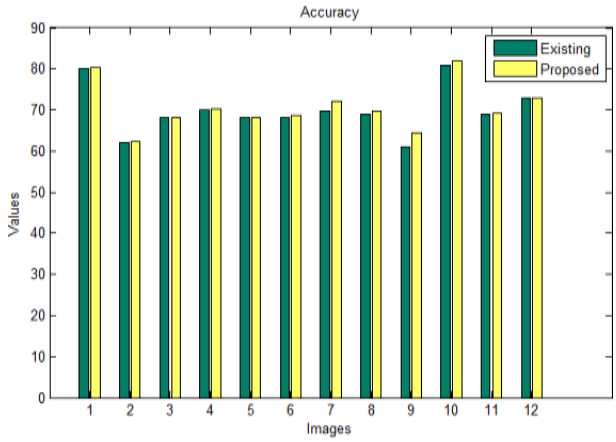


Fig. 5: Gaussian Blur Analysis on Accuracy.

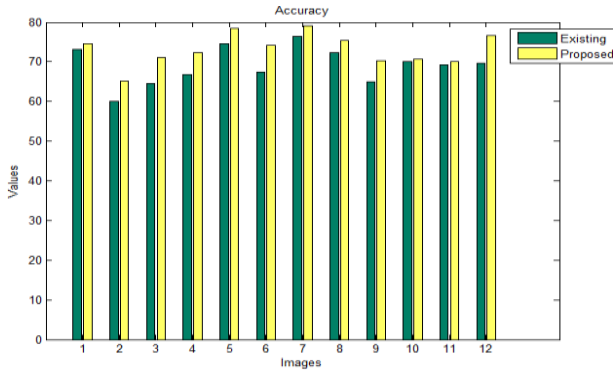


Fig. 6: Focus Blur Analysis on Accuracy.

ii) Bit Error Rate is the rate by which errors come about when transmission takes place. Lower the value of error rate, better will be the result. It can be calculated as:

$$BER = \frac{No.of\ Errors}{Total\ no.\ of\ bits\ sent}$$

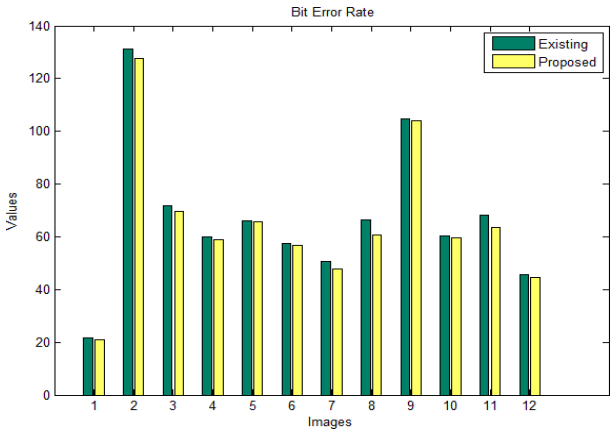


Fig. 7: Gaussian Blur Analysis on Bit Error Rate.

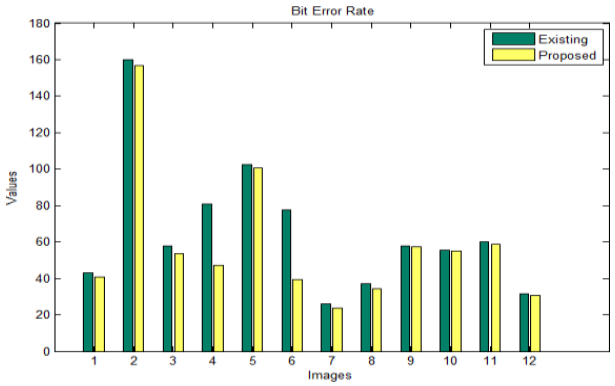


Fig. 8: Focus Blur Analysis on Bit Error Rate.

iii) Specificity is true negative rate which estimates the percentage of negatives that correctly identifies. Results can be obtained by:

$$Specificity = \frac{TN}{TN + FN}$$

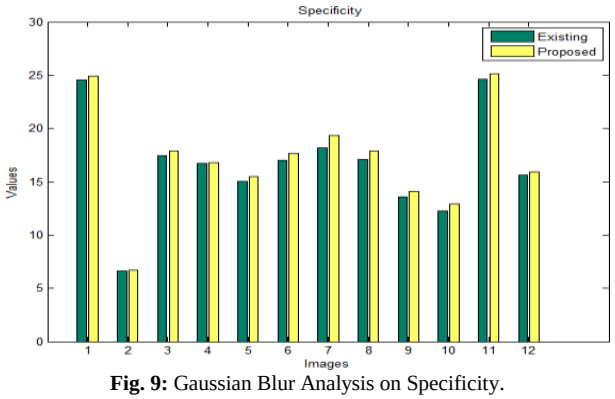


Fig. 9: Gaussian Blur Analysis on Specificity.

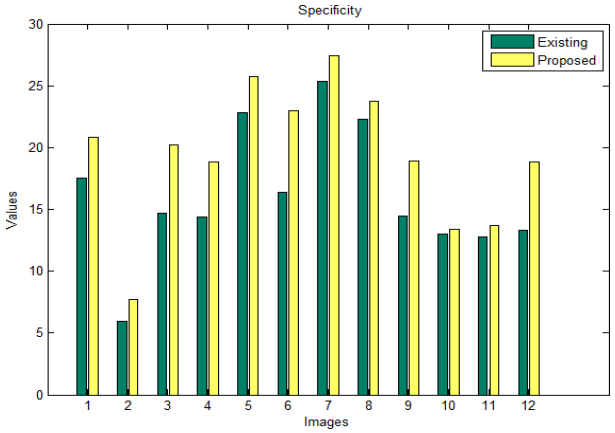


Fig. 10: Focus Blur Analysis on Specificity.

iv) Sensitivity is the rate of true positive that meas- ures the occurrences of positive values that are correctly generated. Results can be calculated by:

$$Sensitivity = TP/(TP + FN)$$

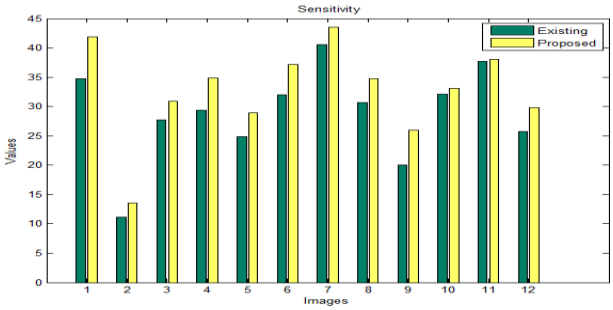


Fig. 11: Gaussian Blur Analysis on Sensitivity.

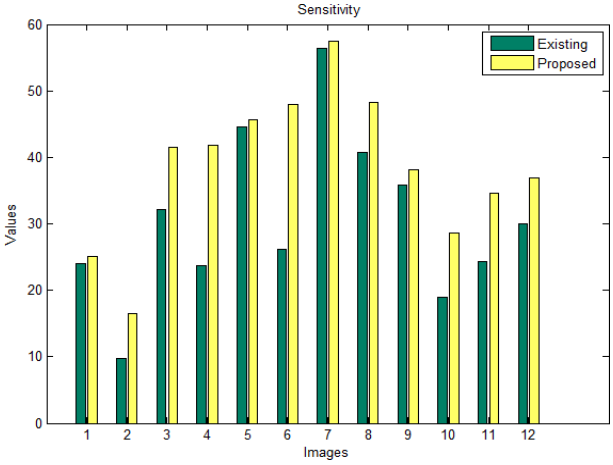


Fig. 12: Focus Blur Analysis on Sensitivity.

v) F-Measure is the measurement value that helps in describing system that estimates or analyse out a value.Accuracy basically yeilds out the error in values.Accuracy can be determined by all correctly measured instances to all instances.

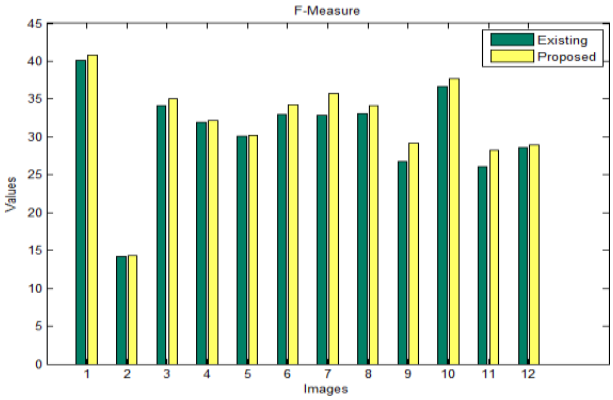


Fig. 13: Gaussian Blur Analysis on F-Measure.

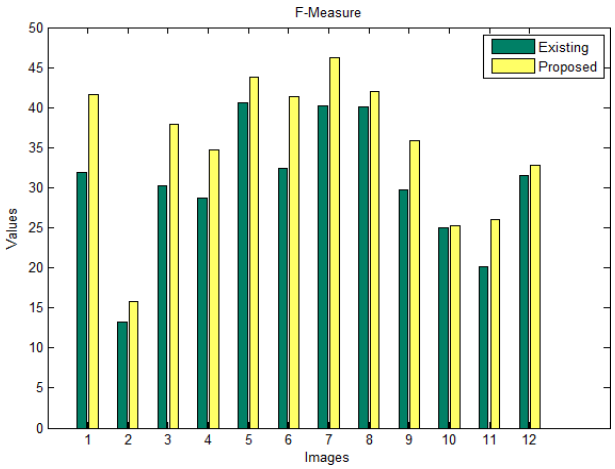


Fig. 12: Focus Blur Analysis on F-Measure.

5. Conclusion

This paper has outlined an algorithm for the detection and correction of blur from blurred images. The arrangement of out of focus blur and gaussian blur kernels plays a fundamental role in the erection procedure of proposed blur detection. We have proposed hybrid technique for the detection and correction of an image using hybrid support vector machine and fuzzy membership function. Mainly existing methods provide satisfied outcome simply for specific blur type. However this proposed technique works well for both of blur types. Numerous experiments are erected by training and testing of set of data on number of images. Moreover, it is used to test the number of parameters such as Ac- curacy, Bit error rate, F-Measure, Specificity and Sensitivity. To estimate the efficiency of our technique, we have compared this with existing method. The produced results are better than earlier technique.

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