Image Quality Meter Using Compression

MUHAMMAD IBRAR-UL-HAQUE*, HASSAM-UL-HASAN**, AND MUHAMMAD IRFAN ANIS**

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ABSTRACT

This paper proposed a new technique to compressed image blockiness/blurriness in frequency domain through edge detection method by applying Fourier transform. In image processing, boundaries are characterized by edges and thus, edges are the problems of fundamental importance. The edges have to be identified and computed thoroughly in order to retrieve the complete illustration of the image. Our novel edge detection scheme for blockiness and blurriness shows improvement of 60 and 100 blocks for high frequency components respectively than any other detection technique.

Key Words: **Image Quality, Image Sharpness, Frequency Domain, Reference Image Quality, Blurring and Blocking, Edge Detection, Image Compression.**

1. INTRODUCTION

Image Quality assignment is the main challenging problem which is faced by the researchers in the field of image processing [1]. A very important factor in image quality assessment is image sharpness/blurriness/ blockiness. The goal of researchers in the field of image quality assessment is to design and develop algorithms that measure sharpness and blurriness in an image. Blur in an image is caused by a lot of factors like defocus, camera shake, motion etc. Blocks in an image are formed by the discontinuity of the pixels in an image. One of the challenging tasks is to design an algorithm to compute the image quality blindly. In certain image processing applications it is very important to quantify the quality of blurred and blocky images.

Identification and locating the sharp discontinuity in the image is referred as, the edge detection. These discontinuities refer to the sudden change in the pixel intensity which characterizes object boundaries in the scene. Edge detection classical methods [2] involves the convolution of an image with 2D filter operator, that is constructed, sensitive to the large gradient in the image, whereas returns zero values in the uniform regions [3]. Since both, the noise and edges contain high frequency contents, therefore detection is difficult in the noisy image signals. If we intend to reduce noise then, edges of the image gets distorted and blurred. Operators or functions which are used for noisy image have generally larger scope and greater value, so these can regulate sufficient data to neutralize noisy pixels. The objective is to design an image quality metric with a reference which can analyze the perceptual blur and blocks in an image. The key cause of distortion in the image signal is due to block based DCT (Discrete Cosine Transform) compression.

* Assistant Professor, Department of Electrical Engineering, Sir Syed University of Engineering & Technology, Karachi.
** Department of Electronic Engineering, Iqra University, Defence View, Shaheed-e-Millat Road, Karachi.

Compression is done through DCT as it is the main source of producing blockiness in an image. Blur in an image is done through a concept called Gaussian blur. Previously various implementations of image quality meter, blurriness metric have been investigated and demonstrated. Image sharpness measurement, image blurring, blockiness compression and many NR (No Reference) [4-5] image quality metric are proposed. No Reference blockiness metric was proposed for image quality measurement. Many edge detection processes were proposed like computational approach [6]. Algorithms which were used for measuring blockiness, use variety of methods for this purpose. The concept of blind measurement for blockiness artifacts in an image [7] proposed the algorithm which was based on FFT computation along the rows and columns for estimating the strength in the block-edges while the concept of detection of blockiness artifacts in the compressed videos [8] used cross-correlation of the sub sampled image signals to compute blockiness metric.

In this paper we introduced a novel solution of implementing an image assessment metric for blurriness and blockiness using edge detection method. Our proposed image quality meter shows better results in image blurriness and blockiness than [4]. The paper is structured as follows. The parts of image quality assessment are introduced in section 1. In Section 2 we presented the proposed algorithm used in the process and desired results. In Section 3 we concluded the whole structure with working and summarize the results and discuss applicability and limitations of our approach.

2. PROPOSED EDGE DETECTION SCHEME FOR BLOCKINESS AND BLURRINESS

The useless information filters out by image edge detection and the amount of data is reduced, while it preserves the image essential structural properties. For the object detection, good knowledge and understanding of the edge-detection algorithm is important, as edge-detection is in forefront the image processing. One method is called the Canny's edge detection method [2] having a convolution mask convolved with the image for sigma, the threshold value. A convolution mask is a small matrix useful for blurring, sharpening and edge detection. The values of a given pixel in the output image are calculated by multiplying each kernel by corresponding image pixel values. Sigma is the threshold value use to control the size of the matrix which is then use to be convolved with the image. The brighter part of this proposed idea is the edge detection method. The **Table 1** shows the steps for working principle of this edge detection technique.

The generated masks requires the value of sigma as an input and generate x and y derivative masks as output. In Canny's edge detection method, the masks used are 1st derivative of a Gaussian in x and y direction. As shown in Fig. 1.

To generate the masks, the first step is a reasonable computation of the mask size. The mask size should not be too large; otherwise it will result in values overhead during convolution. The mask size should not be too small to loose the valuable characteristics of an image.

We consider mask size based on Gaussian and applied a Threshold T. This idea is explained in the Fig. 1. T is a real number between 0 and 1. Width of the mass is considered is based on T.

Firstly, size of half mask, HM is computed by analyzing the point on the curve where the Gaussian value drops below T.

Mathematically expressed in Equation (1):

$$T = e^{-\frac{x^2}{2\sigma^2}} \tag{1}$$

TABLE 1

No.	Steps of Canny's Edge Detection
1.	Generation of masks
2.	Application of masks to image
3.	Compute Gradients
4.	Non Maxima Suppression
5.	Hysteresis Thresholding

Where ó is sigma.

This gives size of half mask HM in Equation (2) as:

$$HM = \sqrt{-2\sigma^2 \log T} \qquad (2)$$

The mask size is then:

$$Mask = 2HM + 1 \qquad (3)$$

Equation (3) is use to include both positive and negative sides of the mask. Therefore for the value of sigma=1, the mask size we get is 5*5. The masks are applied to the images using convolution.

Non maxima suppression lets all edges in M one pickle thick. This is a step that differentiates the canny edge detection technique from other algorithms. The idea is to quantize gradient direction into just four directions.

Hysteresis Thresholding is to apply two thresholds to follow edges because edges have to be followed recursively by looking at the fellow edges with non maxima suppression.

3. IMAGE COMPRESSION

The quality evaluation of an image can be explained as the sum of an undistorted reference image signal and the error signal. Analyzing the error signal with the undistorted reference signal allows to calculate and prepare an image quality meter.

3.1 Image Blurriness and Blockiness

3.1.1 Reference Image or Signal

First, a reference image is being added to the procedure which can be an origin for an image quality meter. Reference image is of high quality with sharp edges and low noise ratio. It is shown in Fig 2.

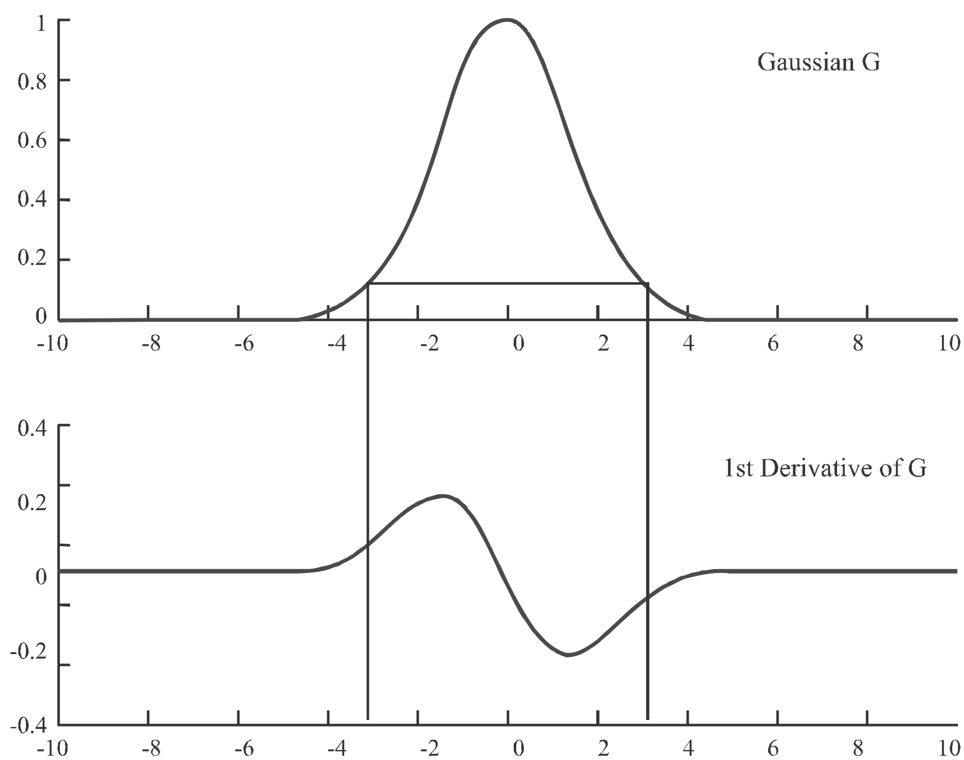


FIG. 1. X AND Y DERIVATIVES

3.1.2 Coded or Error Signal

An image or signal that contains noise or error is added to the image quality metric to analyze it with an error free image. It's shown in Fig. 3.

The idea is to divide the image into sub blocks. This will cause an appropriate method for the computation of the pixels in an image. For Canny's Edge detection an 8*8 block is recommended due to the fact that an image that is being divided into 8*8 blocks will be easier to compute the denser parts in the image and should be able to get the more precise results.

When an image is degraded by excess quantity of blur, identification and classification of elements in the image becomes very difficult. In this paper we have designed an image quality meter for blurry and blocky images which will denote the quality of the image, based on the amount of blurriness and blockiness in the image. The proposed technique is designed in frequency domain.

FIG. 2. ORIGINAL REFERENCE IMAGE [9]

FIG. 3. CODED IMAGE OR IMAGE CONTAINING ERROR SIGNALS

A threshold value is fixed for high frequency components and then the number of high frequency components above the threshold value is calculated. Finally this is used to calculate the image quality score. A sharper good quality image or a reference image with no noise or error signals in it will have higher number of high frequency components compared to a blurred image.

For blockiness, the blockiness metric is implemented such that the image is divided into sub blocks. A DCT is implemented in order to achieve compression of blockiness in an image. DCT represent a finite data point sequences of the sum of oscillating cosine functions at the different frequencies. As shown in Fig. 4(a-c) there are different ratios of DCT compression for image blockiness. The particular data of all the artifacts are well correlated [10]. The overall image quality is determined by the blockiness in-turn. The DCT is mathematically expressed as in Equation (4) [11].

$$X = \sum_{n=0}^{N-1} x \cos\left[\frac{\pi}{N}\left(n+\frac{1}{2}\right)k\right] \qquad k = 0,...,N-1 \qquad (4)$$

Fig. 5 shows Peppers image with varying amount of blur. Uniform blurring in the images is simulated by convolution of image with Gaussian blur kernel. Standard deviation for Gaussian blur kernel is varied to obtain different images. It is also observed when the blur in the image is increased, the number of high frequency components decreases.

Fig 6 shows that more number of white spots are around the centre for the original good quality peppers image and the number of white spots reduce around the centre as the standard deviation of Gaussian blur signal increases which we observe from Fig. 5(b-f). This concept is used to design the proposed image quality measure for blurred images.

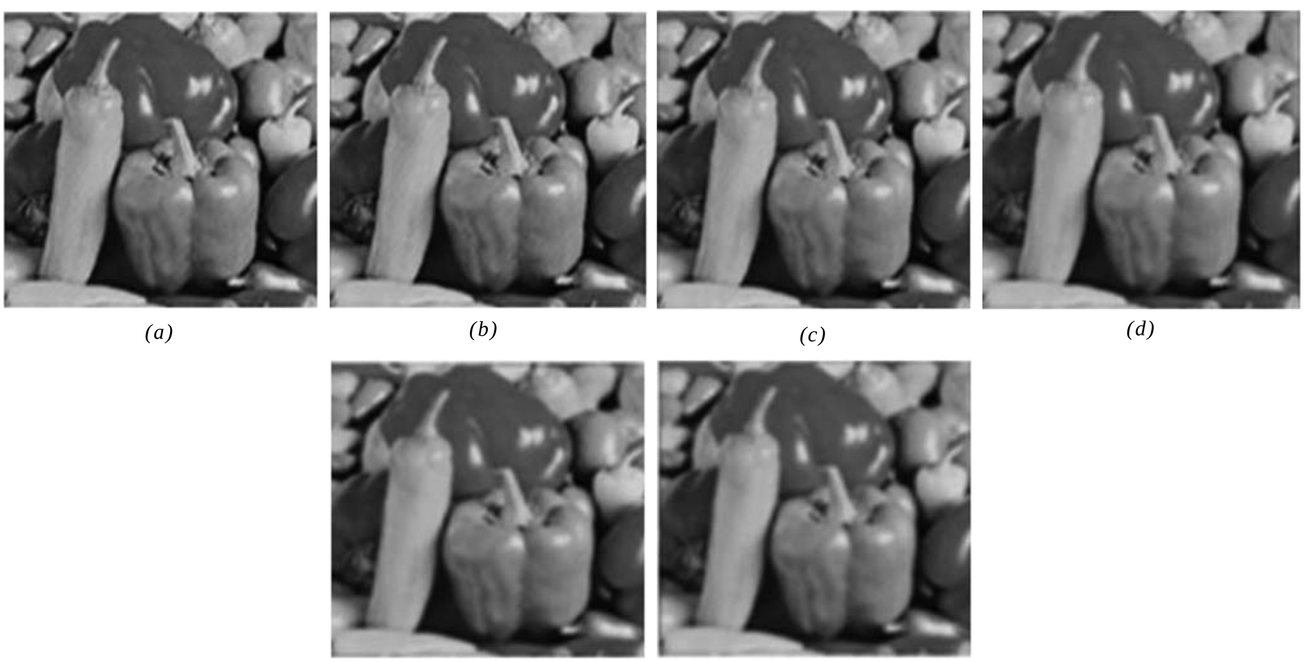
4. RESULTS

Edge detection depends on following steps mainly; smoothing is the blurring of an image to eliminate the noise. The gradients finding is said to be the edges must be noticeable, where the gradients in image have large magnitudes. Non-maximum suppression is just local maxima, must be chosen as edges. Edge detection algorithms are frequently used alongside with non-maximum suppression. The scanning of image is done along the direction of image gradients, and the pixels are set to zero if they are not part of the local maxima. This suppresses all the image information which is not included in local maxima. Double thresholding considered as potential edges are determined by thresholding [10].

The used novel detection scheme for image blurriness and blockiness illustrates prominent result of improved 60 blocks and 100 blocks of high frequency components

(a) (b) (c)

FIG 4.(a) THE ORIGINAL REF IMAGE [9], (b-c) SHOW IMAGES WITH THE COMPRESSION RATIO OF 10.0:1.0 AND 45.0:1.0 RESPECTIVELY.



(a) (b) (c) (d)

(e) (f)

FIG. 5. PEPPERS IMAGE BLURRED WITH GAUSSIAN BLUR WITH DIFFERENT STANDARD DEVIATION (a) ORIGINAL IMAGE [6], (b) SIGMA =0.4 (c) SIGMA = 0.8, (d) SIGMA = 1.20 (e) SIGMA =1.6 (f) SIGMA = 2.0

respectively. In this Paper we proposed the idea of using a convolution mask to detect edges of the blurry and blocky images. The convolution mask of canny's edge detection method convolves with the image such that it acts like a low pass filter. The convolution mask consists of 5*5 matrixes to detect the horizontal and vertical edges.

Convolve the mask matrix with image for vertical edge detection and then by taking the transpose of the same matrix we convolved it with image to have horizontal edge detection. The matrices are given below.

15	69	114	69	15
35	155	255	155	35
0	0	0	0	0
-35	-155	-255	-155	-35
-15	-69	-114	-69	-15

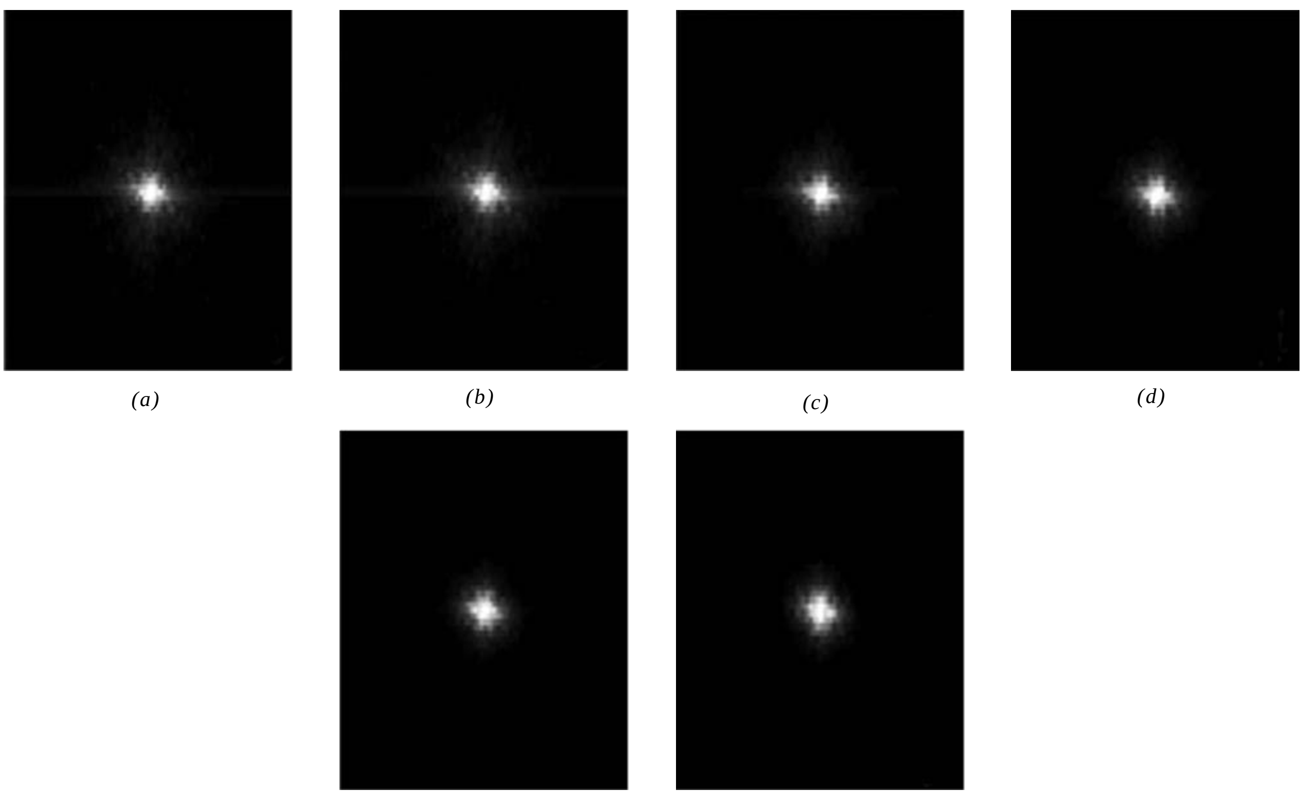
Convolution mask for vertical edge

15	35	0	-35	-15
69	155	0	155	69
114	255	0	-255	-114
69	155	0	155	69
15	35	0	35	15

Convolution mask for horizontal edge

As convolution mask is of 5*5 matrix, this matrix is extracted through the calculation of x and y derivatives and the value of gradient magnitude of the derivatives i.e. sigma.

Here, we are using sigma=1 for 5*5 matrix for edge detection method. Here are some examples of edge detection with different gradient magnitude (sigma) values. As shown in Fig. 7 (a-c). The proposed idea is implemented in Fourier domain using 2D DFT (Discrete Fourier Transform). The frequency spectrum of the signal is shifted at the center of the spectrum and then 2D DFT



(a) (b) (c) (d) (e) (f)

FIG 6. CENTERED FOURIER SPECTRUM OF PEPPERS IMAGE BLURRED WITH GAUSSIAN BLUR OF DIFFERENT STANDARD DEVIATION(a) ORIGINAL IMAGE (b) SIGMA =0.4, (c) SIGMA = 0.8 (d) calculates the components of the image having high frequency. The experiments are conducted on all the images of the BSD (Berkeley Segmentation Dataset) [12]. The number of pixels having greater value than the threshold in both images shown in Fig. 8(a-c) are calculated for good quality image the count is 563 blocks and blurred images 536 blocks. Fig. 8 shows the centered Fourier spectrum for the corresponding images.

As time domain is shifted in to frequency domain, the high frequency components emerged as the results of the image quality metric for blurriness and blockiness. As a result **Figs. 9-10** shows the high frequency components for image blurriness and blockiness and the response of the system how the components are shown in the form of blocks of dots.

As Figs. 9-10 shows the high frequency components in image blurriness and blockiness respectively. The image quality meter contains precise results in image blurriness while in image blockiness the results are more appropriate than previous work [4].

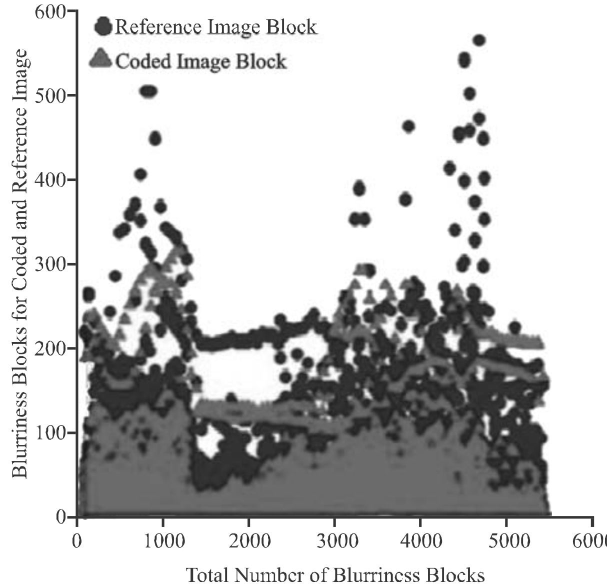


FIG. 9. HIGH FREQUENCY COMPONENTS FOR IMAGE BLURRINESS. BLUE MARKERS REPRESENTING REFERENCE IMAGE FIG 8(a) COMPONENTS ARE 563 AND RED MARKERS REPRESENTING CODED\BLURRED IMAGE FIG 8(c) COMPONENTS ARE 350.

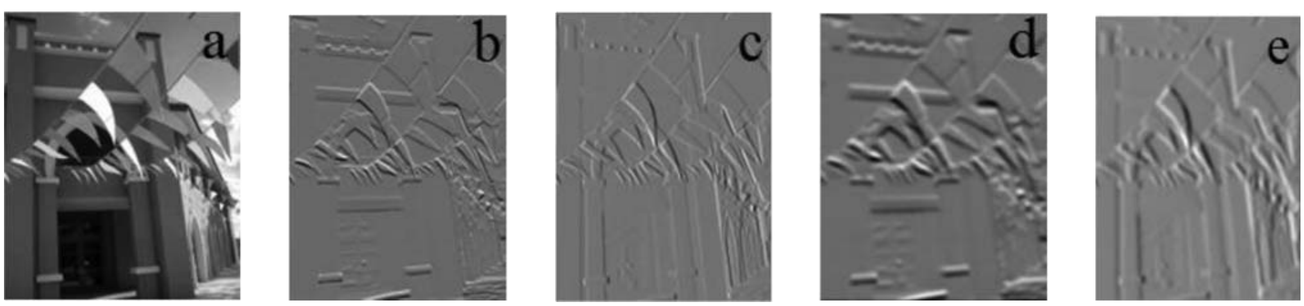


FIG 7(a.) ORIGINAL IMAGE [8], (b) AND (c) SIGMA-0.5 F_X, F_Y, (d) AND (e) SIGMA=2 F_X, F_Y

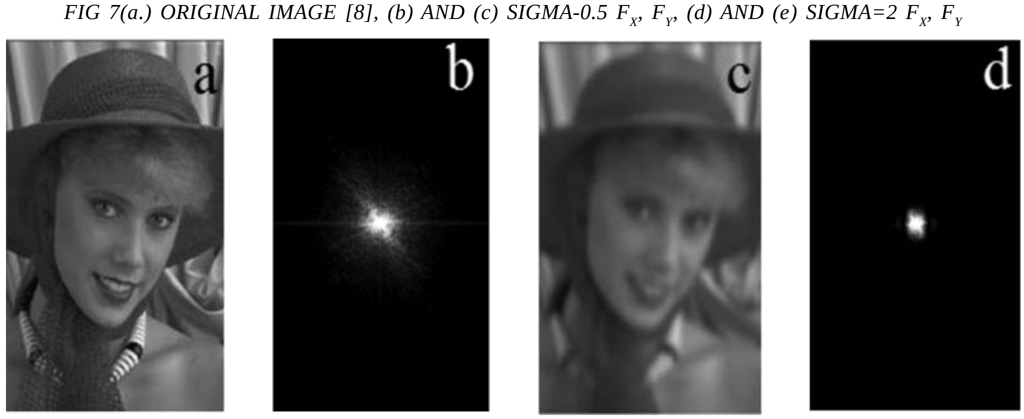


FIG. 8 (a) REFERENCE IMAGE [4] (b) CENTERED FOURIER SPECTRUM OF IMAGE (c) BLURRED IMAGE AND (d) CENTERED FOURIER SPECTRUM OF BLURRED IMAGE.SIGMA = 1.20 (e) SIGMA =1.6 (f) SIGMA = 2.0

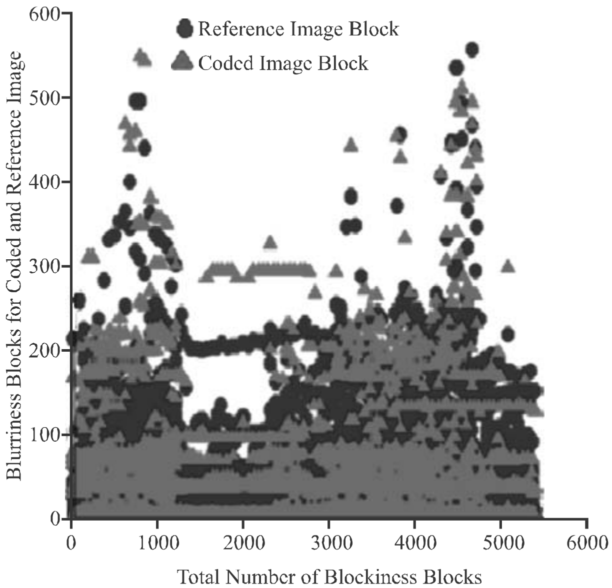


FIG. 10. HIGH FREQUENCY COMPONENTS FOR IMAGE BLOCKINESS. BLUE MARKERS REPRESENTING REFERENCE IMAGE FIG 8(a) COMPONENTS THAT ARE 563 AND RED MARKERS REPRESENTING CODED\BLOCKINESS IMAGE COMPONENTS THAT ARE 536

5. CONCLUSION

We have presented an image quality metric in this paper using reference in image blurriness and blockiness. We have used edge detection method to pass the images through a low pass filter, converted and implemented the calculation in frequency domain by applying 2D Fourier transform. Thus we get the image high frequency components, blurriness and blockiness with reference.

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