IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.414 ⪤ Peer-reviewed & Refereed journal ⪤ Vol. 13, Issue 9, September 2025

DOI: 10.17148/IJIREEICE.2025.13924

A Survey of Various Methods and Techniques for Detecting Blur Images

JEBA PRIYA J[1], Dr. S. PRASANNA[2]

Assistant Professor, Department of Computer Science, Shri Shankarlal Sundarbai Shasun Jain College for Women, Chennai, University of Madras, India[1]

Assistant Professor, Department of Computer Science, Shri Shankarlal Sundarbai Shasun Jain College for Women, Chennai, University of Madras, India[2]

Abstract: The quality of images is essential in computer vision, image processing, and other related fields. Many digital images contain blurred regions, which are caused by motion or defocus. The blur detection algorithms are found very helpful in real-life applications and therefore have been developed in various multimedia-related research areas, including image restoration, image enhancement, and image segmentation. Image restoration is one of the categories in image processing, where the quality of an image plays a vital role in the process. Blur detection is a pre-processing stage in image restoration. Blur detection techniques are used to remove the blur from a blurred region of an image, which is due to the defocus of a camera or the motion of an object. In this paper we represent some methods of blur detection, such as Blind image de-convolution, Low depth of field, Edge sharpness analysis, and Low directional high frequency energy, Haar Wavelet Transform (HWT), Fast Fourier transform (FFT), Laplacian operator, Modified Laplacian (MLAP), Tenengrad (TEN), Gaussian Blurring, Median Blur, Bilateral Blur. After studying all these techniques, we have found that a lot of future work is required for the development of a perfect and effective blur detection technique.

Keywords: Blur detection, Blur image, Image processing, Blur classification, Blind image deconvolution, Edge sharpness analysis, DOF, HWT, FFT, MLAP, TEN

I. INTRODUCTION

In digital imaging, blurred regions frequently occur as a result of camera motion or defocus during image capture. These blur artifacts can significantly degrade the visual quality of images and pose challenges for subsequent computer vision and multimedia analysis tasks. Therefore, the automatic detection and classification of blurred image regions have become critical research topics with applications in areas such as image segmentation, depth estimation, content-based image retrieval, and object recognition. Blur in images can typically be categorized into two major types: **motion blur**, which results from relative movement between the camera and the scene, and **defocus blur**, which arises when the lens fails to focus accurately on a particular depth plane. Identifying not only the presence of blur but also its type is essential for many high-level tasks, including image restoration, adaptive compression, and scene understanding.

Images are used to store or display information, which is very useful. But in many scenarios, the quality of an image is spoiled due to blur. Removing blur and increasing image quality is an important task for blur detection. Various researchers work on blur detection and determine the regions that are blurred. This paper presents a **simple yet effective technique** for the automatic detection and classification of blurred image regions [1].

II. BLUR DETECTION METHODS FOR DIGITAL IMAGE

Images are used to store or display information, which is very useful. But in many scenarios, the quality of an image is spoiled due to blur. Removing blur and increasing image quality is an important task for blur detection. There are many techniques to detect whether an image is blurry or not, and the extent to which it is blurry. Some of them are:

1.) Blind image de-convolution.
2.) Low depth of field.
3.) Edge sharpness analysis.
4.) Low directional high frequency energy.
5.) Haar Wavelet Transform (HWT)
6.) Fast Fourier transform (FFT)
7.) Laplacian operator

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8.) Modified Laplacian (MLAP)
9.) Tenengrad (TEN)
10.) Gaussian Blurring
11.) Median Blur
12.) Bilateral Blur

A. Blind image de-convolution:

The process of deblurring an image where the blur kernel is not known is called Blind image de-convolution. The main advantage of this technique is that we don't require the knowledge of PSF and noise to deblur an image where whereas in other techniques it is necessary that we have previous information about blurring parameters. S.T. Roweis [2] proposed a method for blind image de-convolution and the main goal of this is to produce a sharp or clear image without the previous knowledge of the blurring function (PSF). Sharp image is estimated by input image and the blur function is estimated by the de-convolution algorithm

(a) blurred and noisy (b) deconvolution

Fig. 1: Images of blind image deconvolution (a) blurred and noisy (b) deconvolution

B. Low depth of field:

Low DOF method for blurring Detection is very useful for considering the depth information within 2-D Pictures. Object of Interest (OOI) technique is used in Low Dof. OOI is a photographic technique. Low DOF method for blurring Detection is very useful for considerate the depth information within 2-D Pictures. In Low Depth of field method segmentation of images is done by two ways edge based and region based. The results which are describes by Low DOF offers various application such as, Video Object Extraction, Image Indexing, Image Enhancement, Fusion of multiple Images.

(a) (b)

Fig. 2: Images of Low DOF

C. Edge sharpness analysis.

Edge sharpness analysis is an important technique for blur detection. When the image is clear then the edges that it contains are step edges and when the image becomes blurred then the step edges become ramp edges. A measure of the sharpness or blurriness of edges in an image can be useful for a number of applications in image processing, such as checking the focus of a camera lens, identify shadow of an image having edges less sharp then object edges.

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.414 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 9, September 2025

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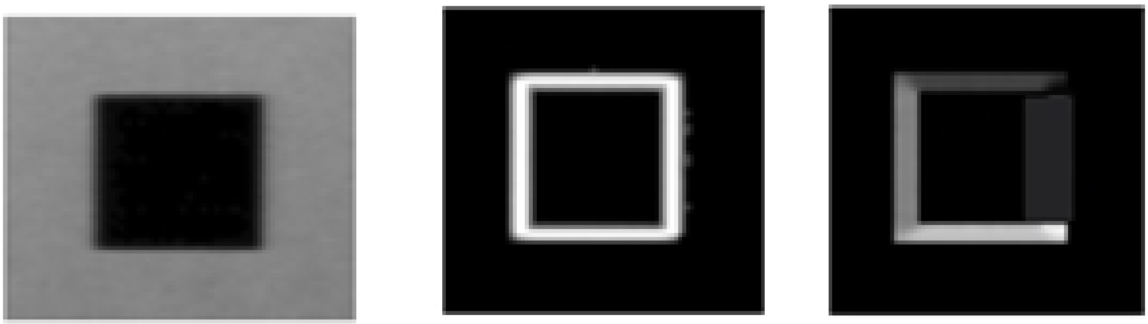


(a) (b) (c)

Fig. 3: An example of blur measurement using Edge sharpness analysis (a)Input Image (b)edge magnitude image (c) Sharp edge Image.

D. Low directional high frequency energy.

The Lowest directional high frequency energy method is used to measure the motion blur. Lowest directional high frequency energy method of motion blur detection has less expenditure on computer resources without the use of PSF estimation. This technique finds the blurred motion region by evaluating the high frequency energy and calculate the direction of the motion of an image which make it more correct then the other methods.

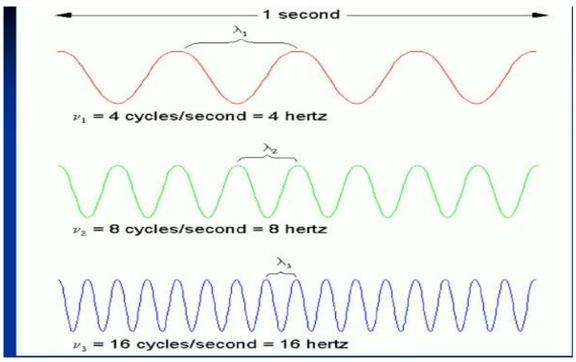
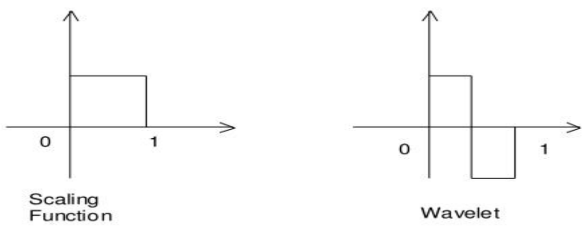


Fig. 3: Low directional high frequency energy

E. Haar Wavelet Transform (HWT):

In this technique the images are split in to NxN by iterating on each tile of the 2D HWT, and grouping diagonally, vertically and horizontally connected tiles into clusters of tiles with pronounced changes. Small clusters containing images are then declared blurred [3].



$$h(n) = [\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}] \qquad g(n) = [\frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}}]$$

Fig. 3: Haar Wavelet Transform

DOI: 10.17148/IJIREEICE.2025.13924

F. Fast Fourier transform (FFT):

In Fourier transform, the algorithm calculates the frequencies in the image at different points and based on the level of frequencies it decides whether the image is blurry or not. When there is low amount of high frequency then it declares that the image is blurry and the decision to what will be the high number of high frequency or low number of high frequency is upon the programmer [4].

G. Laplacian operator:

Laplacian operator is implemented to discover edges in a picture. It is additionally a derivative operator but the basic contrast between different operators like Sobel, Kirsch and Laplacian operator is that all other derivatives are first order derivative but the Laplacian operator is a second order derivative mask. Laplacian operator is further separated into two further classifications which are Negative Laplacian operator and Positive Laplacian operator [5]. One of the main differences between other operators and Laplacian operator is that different operators take out edges in a specific direction but Laplacian operator take out edges in following c1assification: 1. Inward edges 2. Outward edges.

The Laplace operator is a second-order differential operator in the n-dimensional Euclidean space, defined as the divergence (∇·) of the gradient (∇f). Thus if f is a twice-differentiable real-valued function, then the Laplacian of f is the real-valued function defined by:

$$\nabla f = \nabla 2f = \nabla.\nabla f$$

H. Modified Laplacian (MLAP):

The modified laplacian is developed to compute local measures of the quality of image focus. By getting the absolute values of the second derivatives in x and y directions.

I. Tenengrad (TEN):

The well-celebrated focus measure based on image gradients obtained by the convolving the image with sobel operator that can also be considered as blur measure operator [6].

J. Gaussian Blurring:

Gaussian blur is the result of blurring an image by a Gaussian function. It is a widely used effect in graphics software, typically to reduce image noise and reduce detail. It is also used as a preprocessing stage before applying our machine learning or deep learning models. E.g. of a Gaussian kernel(3x3). The Gaussian blur is a type of image-blurring filter that uses a Gaussian function (which also expresses the normal distribution in statistics) for calculating the transformation to apply to each pixel in the image. The formula of a Gaussian function in one dimension is

$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}}$$

In two dimensions, it is the product of two such Gaussian functions, one in each dimension:

$$G(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

where x is the distance from the origin in the horizontal axis, y is the distance from the origin in the vertical axis, and σ is the standard deviation of the Gaussian distribution.

K. Median Blur:

The Median Filter is a non-linear digital filtering technique, often used to remove noise from an image or signal. Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise. It is one of the best algorithms to remove Salt and pepper noise. The median blur technique involves

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
Impact Factor 8.414 ⸎ Peer-reviewed & Refereed journal ⸎ Vol. 13, Issue 9, September 2025
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replacing each pixel in the image with the median value of its neighboring pixels within a specified window. This method is effective in removing noise spikes without affecting the edges of the image.

L. Bilateral Blur:

A bilateral filter is a non-linear, edge-preserving, and noise-reducing smoothing filter for images. It replaces the intensity of each pixel with a weighted average of intensity values from nearby pixels. This weight can be based on a Gaussian distribution. Thus, sharp edges are preserved while discarding the weak ones [7].

III. BLUR DETECTION AND CLASSIFICATION

Image processing techniques can use in the modification of digital data for refining the image qualities with the aid of a computer system. In this paper, we propose an automatic image blurred detection and classification technique that first detects blurred regions within a single image and then identifies the blur type of the blurred image regions. The contributions of our work can be summarized in several aspects.

• First, we observe the connection between image blurs and Input Image Blur Region Detection Singular Value Feature Blur Classification singular value distributions and accordingly design a blur metric that detects blurred regions from a single image accurately.

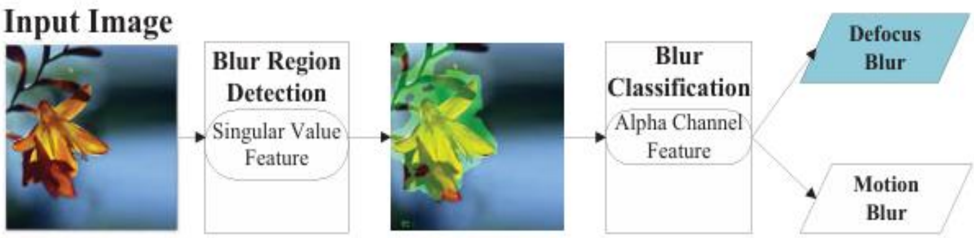

Figure 4: Framework of the proposed image blurred region detection and classification technique.

• Second, we capture the distribution pattern of the gradient of the alpha channel to differentiate motion and defocus blur effectively.

• Third, we build an automatic blur detection and classification system that requires neither image deblurring nor blur kernel estimation. The built system can also be used in many other applications such as image segmentation, image enhancement and image retrieval [8].

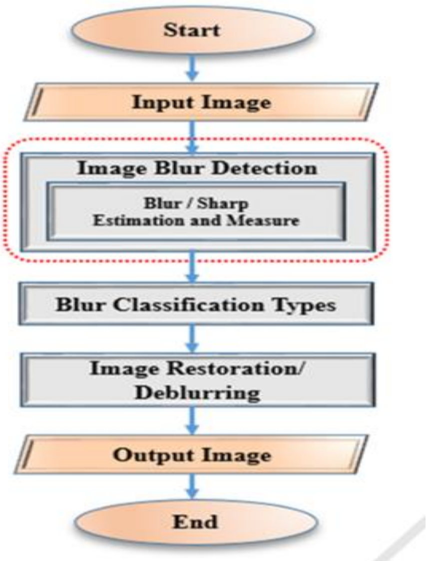

Figure 5: Flowchart of Image Blur Detection Framework.

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

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Impact Factor 8.414 ⁘ Peer-reviewed & Refereed journal ⁘ Vol. 13, Issue 9, September 2025

DOI: 10.17148/IJIREEICE.2025.13924

Figure 5 shows the flowchart of image blur detection framework. The study of narrow down the researches available in public domain about blur images into three major processes: a) image blur detection, the initial process in improving the quality of the image that suffers from blur, b) blur classification, the second process of the research related to blur images. The goal of this process is to classify the blur areas according to their characteristics or types, and 3) image restoration, the third process, perform deblurring process based on their characteristics.

IV. ADVANTAGES AND DISADVANTAGES

Researches on blur detection are very useful for improving the digital image quality, possible aiding in crime solving with video quality improvement and restoration of some precious images in our daily life.

TABLE I: Advantages and Disadvantages of the Reviewed Methods

Method	**Application**	**Advantages**	**Disadvantages**
Blind image de-convolution. Blind image de-convolution [9][10][11][12][13].	Preliminary step for de-blurring process.	Potential blur region in image can be detected effectively.	User interaction is needed for correctly estimated PSF and kernel structure.
Low depth of field. Low depth of field (DOF) image segmentation [14][15][16] [17].	Photography.	OOI (object of interest) able to be identified effectively.	Only effective for low DoF (Depth of field) image.
Edge sharpness analysis Edge sharpness analysis [18][19][20][21].	Blur extent measurement based on image intensity profile.	Lower computational cost and time.	Not effective for complex image.
Low directional high frequency energy. Lowest directional high frequency energy (for motion blur) [22] [23].	Motion blur detection	A robust closed form solution is derived for motion blur detection.	Only effective to motion blur image.
Haar Wavelet Transform (HWT) [24].	Splitting and grouping into clusters	Data compression, noise reduction, and feature extraction	Not very effective for complex image.
Fast Fourier transform (FFT) [25].	Calculating frequencies at different points	Focus the image is blurred or sharp.	Only effective to out of focus image.
Laplacian operator [26].	To discover edges in a picture.	Only high-quality images	Complex to implement
Modified Laplacian (MLAP) [26].	local measures of the quality of image focus.	To enhance or smooth images and meshes	Not very effective for complex image.
Tenengrad (TEN) [26].	Image gradients	Image sharpness based on edge strength	Only effective to out of focus image.
Gaussian Blurring [27].	Applying a Gaussian function to an image, resulting in a smooth blur.	Fast computation and effective Reviewed blur identification.	Sampling of large database needed prior to detection.
Median Blur [27].	Removing random black and white pixels	Lower complexity and does not need original signal information.	Not very effective for complex image.
Bilateral Blur [28].	Smoothening images and reducing noise	Effective and robust in detecting out of focus blur.	Only effective to out of focus image.

V. CONCLUSION

Blur Detection is a technique to remove the blur from a blurred region of an image which is due to defocus of a camera or motion of an object. In this paper we will study the various method for blur detection such as blind image de-convolution, Low DOF, Edge sharpness analysis, Low directional high frequency energy. In Blind Image de-convolution,

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we don't, require the prior knowledge of PSF and noise parameters which are the main advantage of this technique over other techniques. In Edge sharpness method we detect the blur in an image through the intensity of an image profile. This method has low computational cost but not effective on complex images over other methods. All these methods of blur detection are used for various applications such as: Video Object Extraction, Image Indexing and Enhancement, Fusion of multiple Images, Scene understanding and segmentation applications and measurement of depth. From this survey, we can conclude that blur detection is still a popular research area with potential of further advancement in the future. This review also shows that each of the blur detection method has active research value and expected to increase for years to come.

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