Volume 5, Issue 11, November 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

A Survey on Image Deblurring

Shanthini.B
PG Scholar,
Dept of CSE, Sri Shakthi Institute of Engineering and Technology, India

Mahalakshmi.A
Asst. Prof,
Dept. of CSE, Sri Shakthi Institute of Engineering and Technology, India

Abstract- The blur removal due to camera shake and motion of the scene is been considered as a research topic in Image processing. To build a more sharper and reduced blurred image, an algorithm can be selected which is capable of grouping a burst of images (or more than one burst for high dynamic range), from that less blurred image from each frame can be preferred through a weighted average in the Fourier Transform. It found to be a better method to reduce the blur in the burst of images. The algorithm is simple to implement and easy to define theoretically. With a weighted average, the method can be seen as an overview of the align and standard procedure provoked by hand-shake physiology to choose the sharpness image selection and it is supported theoretically. The calculation of a weighted average of the Fourier Coefficients for the images in the burst can be generated by considering sequence of registered images as an input. An algorithm "Monte Carlo approach" has been proposed to reduce the computation complexity and to improve the quality of the image. After the process of deblurring, the improved quality of the image is capable to spot the specific exposure time.

Keywords: weighted Fourier coefficient, point spread function, deblurring

I. INTRODUCTION

A blur is a shape or area which cannot see clearly because it has no distinct outline or it is moving faster. If we are able to recognize the shape of the objects clearly then that image is considered to be the sharper or more comprehensive image. For example, a clear image of the face can be shown when we can be able to recognize eyes, ears, nose, etc very clearly. Edges are the one which shows the shape of an object. Some of the major techniques that are widely used in image processing are pattern recognition, video processing, microscopic imaging etc. Motion blur occur due to camera shake, slow shutter speed causes even slight camera motion to cause blurry photos and fast shutter speed freezes motion despite camera shake when shooting hand-held camera. To understand the deblurring concept, various causes of blurring must be studied.

Causes of blurring:

The following are the some of the causes of blurring:-

1. While capturing an image, the movement and the long exposure time made by the user is one of the causes.
2. The next cause is the number of photons captured can be reduced when an out of focus optic, use a wide angle or a short exposure time.
3. Another cause in confocal microscopy is the sprinkled light deformation.

Deblurring model:

The following equation represents the blurred or degraded image:

$$b = Po + N$$

where, b represents blurred image, P represents the distortion operator also called the Point Spread Function (PSF). o represents the original true image. N is additive noise, initiated during image acquisition, due to which the image gets corrupted. The main aim of deblurring is to describe the deformation exactly by deconvolving the blurred image with the PSF model. The major need of PSF is the method of reversing the convolution effort is called as deconvolution process.

Based on the complexity order, there are 4 deblurring functions which are included in the toolbox. Accepting a PSF and the blurred image are the most important arguments for all the functions.

1. Deconvwnr: The least square solution can be generated. Noise amplification can be reduced by using the gained information regarding the noise during the process of deblurring, for which the wiener filter is helpful.
2. Deconvreg: A constrained least squares solution is generated for locating the constraints on the output image. Here regularized filter is helpful for deblurring process.
3. Deconvlucy: It generates an accelerated damped Lucy-Richardson algorithm. Optimization techniques and Poisson statistics can be used for generating multiple iterations in this function. Information about the additive noise is not provided in corrupted images.
4. Deconvblind: Without the awareness of the PSF, the deblurring process can be undergone by the blind deconvolution algorithm, which gets generated by deconvblind. Along with the restored image it returns a

restored PSF. The dampling and iterative model are used by this function. The following things are to be noted while performing the process of deblurring:

Deblurring is an iterative process which considers different parameters for each iteration. This process will be continued until the received image is based on the information range which seems to be the best of the original image. Before entering into the deblurring process, preprocessing has to be performed using edge tapper function in order to keep away from "ringing" in a deblurring image.

A Fourier series is a series expansion of a function based on the special properties of the complete orthogonal system of functions. For example, a Fourier series is based on the biorthogonality of the functions cos (nx) and sine (nx) which is integrated over the range $[-\pi, \pi]$.

The Fourier series of a function f(x) is given by

$f(x) = e + \Sigma a_n \cos(n x) + \Sigma b_n \sin(n x)$,

Where the coefficients are

$a_n = 1/\pi \int_{-\pi}^{\pi} f(x) \cos(n x)\, dx$

$b_n = 1/\pi \int_{-\pi}^{\pi} f(x) \sin(n x)\, dx$

$e = 1/2\pi \int_{-\pi}^{\pi} f(x)\, dx$.

Some of the applications are described as follows:

- **Photography:**

The images that are captured by the modern camera can be manipulated for getting the better image through zoom, sharpening, image recognition and image retrieval.

- **Medical field:**

X ray imaging, medical CT etc are the major application in the medical field where the image processing techniques are applied. Computed tomography images allow doctors to get very precise, 3D view of certain parts of body, soft tissues, lungs etc.. Magnetic resonance images (MRI) uses radio waves and magnetic field to create detailed images of organs and tissues.

- **Entertainment:**

Video processing involves reducing the noise, detect the motion, detail enhancement, conversion of frame rate, conversion of aspect ratio, color space conversion.

- **Natural Disaster:**

Satellite can be used for scanning the earth's area for gathering the information about it. It is used to detect infrastructure damages caused by an earthquake. The different types of earthquake damages can be analyzed and detected from the affected area image captured from the earth.

- **Education:**

The images are used in teaching and learning field which provides various benefits to support student comprehension, retention and application.

II. LITERATURE REVIEW

A. Non-uniform deblurring:

O.Whyte [1] analyzed that the observed image uses current deblurring methods with the uniform kernel as the convolution of sharp image. In terms of the rotational velocity of the camera, the parameterized geometric algorithm has been used. The camera shake removal has the two different algorithms: blind deblurring and Deblurring with noisy / blurry image. Along with uniform blur, wide range of blur can be removed by this algorithm. The blur kernel can be estimated and obtain the sharp image by "deconvolving" the blurry image. The uniform blur can be removed by applying within a multiscale framework. Richardson- Lucy algorithm is used for deconvolution. The causes of blur are the size is inversely proportional to the depth of the scene. The 1^0 rotation represent the smaller motion of the camera.

B. Multi-Image Denoising

In this paper the author, T.Buades[2] described that the photos that are taken by using hand held camera under low light condition is more problematic .The motion blur is caused by using long exposure and the noisy image is caused due to short exposure. In this paper complex image processing chain algorithm is efficiently used for denoising the multi images. This algorithm includes various techniques like noise estimation, video equalization. The non parametric camera noise can be estimated efficiently. Image fusion is the technique that is used for the combination of multiple images into single image. There are various methods for image denoising that are used to remove or separate noise from the image. Object/ image retrieval, scene parsing are the major application in the image matching.

C. Multi-image blind deblurring

The author, H.Zhang [3] studied that the blur kernels, levels of noise and unknown latent image can be coupled by using Bayesian-inspired penalty function which is used to solve multi-image blind deconvolution. There are no essential parameter for recovering quality image, whereby the relative concavity is adapted by the coupled penalty function, which contain potentially both blurry and noise images. The sharp and clean images can be estimated by using the multi-image blind deblurring. $y_l = k_l * x + n_l$, k_l is a Point Spread Function (PSF) , $*$ is the operator for convolution , and n_l is a Gaussian noise term with covariance $\lambda_l I$ [3].The premature convergence is avoided by the penalty function, which is highly desirable and course structure can be accurately identified.

D. Blind motion deblurring

In this survey Motion blurring, is complex to remove by using the technique called blind deblurring. The clear image with high quality is recovered by Multi frame approach. The author, Boracchi[4] analyzed that the clear image can be restored and blur kernel can be identified from the given blurred images by using the approach called alternative iteration. Accurate estimation of blur kernel and minimization problem can be efficiently solved by the linearized Bergmann iteration. Short shutter speed is used to produce a clear image with the limited light. Non blind deconvolution and blind convolution are the two different types of image deconvolution problem. Non blind deconvolutions mainly focus on an ill-conditioned problem, and the solution for the problem is reversing the effect of convolution on the blurred image. The problems in blind deconvolution such as blur kernel and clear image is unknown and can be resolved by infinite solution, one can be under constrained.

E. Image restoration from motion blur

In this paper the author, J.Flusser [5] studied that restoration algorithm is used to remove the motion blur based on blur amount. The identification of best balance is very difficult in restoration task. In case of the arbitrary motion, performance of restoration can be analyzed by the deblurring algorithm such as point spread function and monte-carlo approach. The restoration performance is based on the three relevant deconvolution algorithms: the Anisotropic LPA-ICI Deblurring, Sparse Natural Image Priors deconvolution, and the Richardson-Lucy Deconvolution [4]. The motion is measured the hybrid imaging system by using the first algorithm. The inversion of blur is done by Richardson-Lucy Deconvolution; the motion information is used compute the blur PSF. The noise parameters are estimated by Anisotropic LPA-ICI and the Lucy Richardson Deconvolution and the noise model can implicitly addressed by Sparse Natural Image Priors deconvolution. The three deconvolution is used for increasing the quality of the image restored during exposure time.

Table I. Comparision table on different techniques

Model	Functionality	Advantage	Disadvantage
Parametric geometric	This model is used for deblurring the blur in the uniform kernel. The algorithm in this model is blind and blurry/noise deblurring.	The image that are sharp and blur kernel are estimated and used to accurately reconstruct the observed blurry image.	Non-uniform blurs are not investigated and this model is not applicable for non-static scenes.
Multi-Image Denoising	The algorithm is efficiently used for denoising the motion blurs and noise image caused due to long and short exposure	It is used to estimate a camera noise that are non parametric from any burst of images.	Some dust cannot be removed that are stick to the camera, and Non-Local Means loss the fine texture details.
Multi-image blind deblurring	Bayesian-inspired penalty function is used to solve multi-image blind deconvolution which is coupled with blur kernels, levels of noise and unknown latent image.	The blur kernels are recovered with high quality and the unknown latent image can be recovered.	Optimization is difficult, video deblurring and non-uniform deblurring is not implemented.
Blind motion deblurring	Accurate estimation of blur kernel and restore high quality clear image by multi frame blind deblurring approach. Linearized Bergmann iteration is also used.	The clear high quality image can be recovered automatically.	The blurred images on out-door scenes is more difficult to deblur due to complicated 3D structures.
Image restoration	The restoration algorithm is used reduce the blur amount and the noise. Monte-carlo approach is used to face the restoration performance	The restoration error can be estimated and used to solve optimization problem.	The expected restoration error cannot be estimated by Point spread function.

III. PROPOSED SYSTEM

The basic principle of photography is the more number of the photons that are accumulated to provide the better quality of the images. Initially identification of the blur or the noisy pixel taken from the hand –held camera is found to be very difficult. Fig.1 can be explained as follows:- An algorithm is used to aggregate the burst of blurred images for deblurring which can overcome the difficulty of the previous method.

After deblurring process the output image without blur and noise is produced. The deblurring process contain following three mechanism. The noise removal mechanism, feature extraction using Scale Invariant Feature Transform technique, weighted Fourier transform.

Apart from the previous techniques various other techniques which are involved in the paper are described below:-

A. Noise Removal Process

Noise removal Process is the process of removing a noise from a signal. Noise can be random or white noise with no coherence, or coherent noise introduced by the processing algorithms. Linear filtering method can be used to eliminate the different types of noise in burst of images. The suitable filter used for accumulated burst images is averaging or Gaussian filters.

B. Convolution Technique

Convolution method is processed using two function f and g which creates a modified third function all these comes under mathematical calculation. The Convolution Image is a small matrix which is useful for sharpening the image, embossing, and detection of edge. This is can be done by means of convolution between a kernel and an image.

C. Image Intensity

Intensity images measure the amount of light impinging on a photosensitive device. It is used to calculate the color intensity of each feature on the multi image blind convolution. Intensity of the each feature is calculated using the histogram method.

D. SIFT Technique

An image can be taken and transformed into "large collection of local feature vectors" for feature generation by Scale Invariant Feature Transform (SIFT) approach. Scaling, rotation, or translation of the image is invariant to feature vector.

E. Weighted Fourier Coefficient

This coefficient is grouping and ranking the images based on the multi blind convolution image. Weighted average in the Fourier domain, with weights depending on the Fourier spectrum magnitude is computed based on the blur regions extracted from the SIFT technique with information about the amplitudes, frequencies and phases of the basic cosines spanning the function of which an interval having a length of integer number of periods.

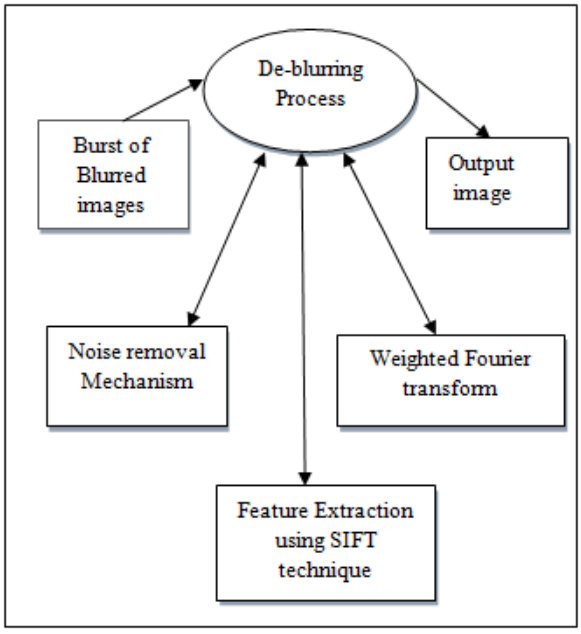

Figure 1: Architecture Diagram

IV. CONCLUSION

Different blur images from the hand held camera, phones etc are taken for making the image very clear without any blur. The deblurring process is used to remove the noise, sharpen the image and improve the quality of the images. Weighted Fourier Coefficient method has been proposed to overcome the challenge which has been discussed in the paper. This experiment can provide better results than the previous approaches for removing the blur and also improve the computational complexity.

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