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Techniques in De-Blurring Image

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Techniques in De-Blurring Image

Rasha Muthana[1], Assad N. Alshareefi[2]

[1]Department of Computer Science, Faculty of Computer Science and Mathematics, University of Kufa, Najaf, Iraq

E-mail: rasha84mj@gmail.com

[2]Department of Computer Science, Faculty of Computer Science and Mathematics, University of Kufa, Najaf, Iraq

E-mail assad.alshareefi@uokfa.edu.iq

Abstract. Images nowadays are an integral part of our lives, whether in scientific applications or social networks and where there is an image, the concept of image blurring may occur. Blurred is a major cause of image degradation and reduces image quality. Blur occurs due to air noise as well as incorrect camera setup. Along with the blur effects, the noise also spoils the captured image. Deblurring is the operation for removing blur or noise and restoring the underlying high-quality image. Blur can be different types like Motion Blur, Gaussian Blur, and Average Blur.
Key words: image processing, blind deconvolution, de-blur, PSF (point spread function), PSNR (Peak Signal to Noise Ratio).

1. Introduction

Removing the blurry from the image is a significant problem with many applications, included diagnosis of medical conditions, astronomical data analysis, security and surveillance. Image interrogation, for example, extracting and splitting features, was easier if the image on which these processing were performed is of high fineness, so deblurring an image might be considered as a pre-processing process for subsequent image interrogation. The importance of this stage before processing, Deblurring is the operation for removing blur or noise and restore high quality image. Noise also spoils the image so we need to do noise removal on the image (L. Zhong et al 2013, M. S. Shakeel & W. Kang 2015). Image de-noising is also a part of image Deblurring. Applications of Deblurring include Iris recognition (N. Liu et al 2007), Image segmentation (W. Ren et al 2017, T. Askari, J. Hamid, & H. Vahid 2017), Information retrieval (A. Husni et al 2017), Astronomy (A. Fiandrotti et al 2017), Microscopy (L. Han & Z. Y. B 2017), Space observation (X. Zhihai et al 2017), Video object extraction (H. Jeon et al 2017), etc. There are many types of blurs like an Average blur, Motion blur, Defocus blur, Gaussian blur, etc. shown in Figure 1.

Figure 1. (a) Average Blur (b) Motion Blur (c) Defocus Blur (d) Gaussian Blur.

2. Type of Blur

Motion Blur: Numerous kinds of motion blur might be distinguished (J. Cai et al 2012), and all result from the relative movement between the recorder and the scene. That possible to be in the form of translation, rotation, abrupt change in volume, or several combination of them. The effect of Motion Blur was a filter that made the image show like it moves through adding blur in a certain direction. Can be controlled the motion through the angle or direction such '(0 into 360 ° or from -90 into +90) and / or by the distance or intensity in pixels (0 to 999)', that depending on the software are used.

Average Blur: That was one of numerous tools which might to be utilize into removed the blur and noise from an image. Can be used it when there was noise on the input image. That kind of camouflage might be distribute in the horizontal and vertical direction and may be distribute like a circular mean during the radius R. It was estimated by the following:

$$R = \sqrt{g\,2} + f2 \qquad (1)$$

That g was the direction of the horizontal size blurring, and f was the direction of the vertical blurring volume.

Out-Of-Focus Blur: When the camera is shooting a 3D scene on a 2D launch plane, some areas of the scene are centered whilst others are not. If the camera aperture is circular, a small disk is formed at any point source of the image, recognized as the circle of confusion (COC). The distance between camera and object and the aperture number of the lens has greater importance to determine the degree of focus (the COC diameter). The model accurately represent the diameter of the (COC) as well as the dispersion of density within the COC. This study involves the deblurring of motion blurred image which either caused by camera shake or object motion.

Gaussian Blur: Gaussian blur was the outcome of a blurred Gaussian function image (Aizenberg I. et al 2002). It was widely utilized in graphics programs, usually to minimize image blur. In computer vision algorithms, it is also used as a pre-processing step to enhance image structures at different levels. This type of blurry impact is a kernel that gradually collected a certain number of pixels, following a bell-shaped curve. Thick blanking in the center and feathers on the edge.

3. Deblurring Model

An almost unclear or decaying image be able to describe by:

$$g = Hf + n \qquad (2)$$

That g was represent the blurred image and H referred to the distortion factor, known as the point spread function (PSF). In the spatial domain, PSF distinguishes the rate at whom the optical system blurs the light spot. PSF referred to a reverse Fourier transform of the optical transfer function (OTF). In the frequency domain, the (OTF) describes the reaction of a linear system, and a fixed position of the pulse. OTF is obtained as the Fourier transform of the point spread function (PSF). Deformation is created when the image is intertwined with the degradation factor degradation result from the point spread function is only single kind of distortion, representing f as an input image, and n was representing the added noise, introduced through image acquisition that was corrupts the image. De-blurring Image and restoration are so essential in digital image processing, because images are acquired in areas ranging from usual photography to astronomy, remote sensing, medical imaging, and microscopy. An Image blur was intricate to avoid in much situations and might oftentimes damage a photograph. Everybody is familiar with camera shake, when photos taken in low-light conditions the blur may result. Whilst significant progress have been made lately towards removing that blur from the images, generally almost all current advances this problem model the blurred image as the convolution of a sharp image with a linear filter. However, in real camera shake, which is depicted as the rotation of the camera during exposure, does not result a uniform blur. Recently there are many approaches exist to remove motion blur from photographs, various deblurring techniques are discussed based on a single image and a pair of images. We can describe the degradation process as the following system.

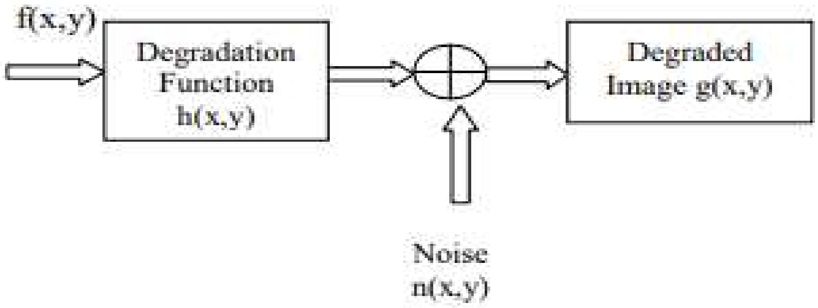

Figure 2. Deblurring image.

An original input was performed as a two-dimensional image f(x, y). These image was performed on system h (x.y) and after adding noise n(x, y). We might obtain the degraded image g(x, y). Digital image restoration may be seen as an operation in that we attempt to approximate f (x, y). That blurred image might be explain with the following equation.

$$\mathbf{g}(\mathbf{x},\mathbf{y}) = \mathbf{h}(\mathbf{x},\mathbf{y}) * \mathbf{f}(\mathbf{x},\mathbf{y}) + \mathbf{n}(\mathbf{x},\mathbf{y}) \qquad (\mathbf{3})$$

4. Deblurring Technique

Deblurring Based on Edge Spread Function: (Artemy Baxansky & Meir Tzur 2010) presented a novel algorithm to remove shake from camera from one input image, the point spread function was performed in provisions of the angular speed of the cameras. The edges in the blurred basic image were supposed to be perfect step edges. a cross-section of the edge in the blurred image grant the PSF convolution together with the step function, called the edge spread function (ESF), which estimated from separated border within the image edge spread function are evaluated from the secluded edges. The cross-section closely follow up the ESF in the opposite direction. The motion PSF Model is approximated by using the linear velocity which is the rate of change of camera motion with respect to time, then is related to angular velocity. PSF corresponding to this motion is calculated by sampling the time axis. The best matching PSF is estimated as a combination of the information from all directions. The image restoration is done by Wiener filter, Followed by the following algorithm - treated to diminish the effect of ringing. The algorithm is strong, accurate, and easy.

De-Blurring In Neural Network: As known the neural networks represent as a kind of multiprocessor in computer system, in collection of easy operating elements, a maximum level of interconnection, As well as the interaction between the elements. If an element in the neural network was fails, they will be continue without any trouble due to its parallel naturally (Aizenberg I. et al 2002).

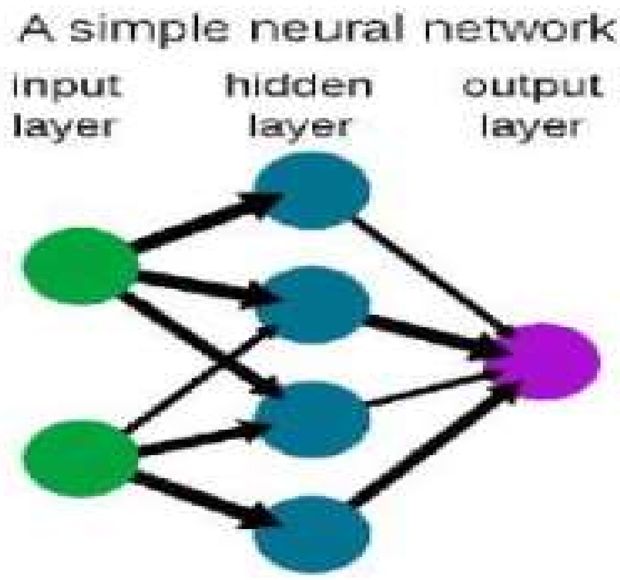

Figure 3. Neural Network Approach.

ANN supply a powerful tool for approximating the target operation whilst giving an example of the input set output and reconstruction function from a class an images. This algorithm like as a back propagation and perception utilize decent gradient technologies to better adjust network parameters to better fit a training collection of input and output symbols. If use a neural network approach for posterior diffusion to restore the image. This process is capable of study complex nonlinear operation and predictable into reproduction a best structure mostly in high frequency areas in the image.

Deblurring In Spatially-Variant Based On Image Pair: (Michal Sorel and Filip Sroubek 2009). Use a way to de- blur the image by using a pair of burly image and clear images. Blur was not uniform in case of camera shake, this operation can be performed by a more general linear function.

$$B = I *_{\text{v}} K[x, y] = \int I(x - s, y - t)\, K(x - s, y - t; s, t) ds\, dt \tag{4}$$

It is a convolution of original image I together with a mask K that differences with its position (x-s, y-t) in the image. Because the camera's rotational motion, the motion blur is autonomous from the depth and PSF is changes steadily. Therefore we can consider the blur as a locally fixed and can be rounded locally by convolution. By utilizing this feature, the image is divided into rectangular windows and only a small group of nuclei is estimated. The estimated core is assigned to the center of the windows, in the remnant of the image, the PSF is rounded by a linear interpolation from the four neighboring blur kernels. It is an extension of a disparate pattern of blur, which can remove artifacts that usually arise in the outer areas.

Blind Deconvolution Model: Basically we have two kind of deconvolution procedures. These projections based on blind- deconvolution and large probability restoration 'non- blind deconvolution'. On a first method, it restores together the true image with point spread function. These start through the primary estimates of the input image with PSF. This technicality is cylindrical in nature. In the beginning we shall find the PSF estimate and it was follow up by image estimate. These cyclic operation was iterative till to a predefined convergence criterion is met. One of the advantages of this method is that it seems strong because of the inaccuracy of the volume of support and also this approach is not sensitive to noise. The issue here is that they are not single and this method can contain errors associated with the local minimum (D. Kundur & D. Hatzinakos 1998). In the second approach, estimate the maximum probability of parameters such as PSF matrices and covariance matrices. Since (PSF) estimation is no other individual presumption such as symmetry, size etc. of the PSF might to be taken into account. So the major advantage is that it has lower arithmetic complexity and as well as helps get noise, noise and spectra blur for the real picture. The obstacle in this methodology was that the algorithm meets the local minimum cost allocation (A. Levin et al 2011).

Deconvolution Using Lucy-Richardson Method: (William Richardson & Leon Lucy 1972, Lucy & L. B 1974) invented the LR which is a repeated process to retrieve a latent image that has been blurred by a known PSF. In this case, PSF is identified but no information is available for the noise. One main problem with basic LR method is how many times process should repeat. If the numbers of iterations are very large then it will slow down the computational process and also introduce ringing artifacts. The equation of Richardson-Lucy algorithm is, (Z. Al-Ameen et al 2012, E. Shaked et al 2011).

$$f^{n+1} = f^{n}\, H^{*}\left(\frac{g}{Hf^{n}}\right) \tag{5}$$

That f^{n+1} *referred as* the new estimate from the prior one is f^{n} , (g) referred as the blurred image, (n) represent as the number of the step in the iteration, (H) represent the blur filter (PSF) and (H*) refereed as the Adjoin of (H).LR algorithm reduces the effect of noise amplification. It is time consuming because more iteration is required. In literature (E. Shaked et al 2011, D. a. Fish et al, J. Ding et al 1995), RL algorithm is being used to restore the final and latent image. (Shaked et al 2011) represent an extended version of RL algorithm for estimation of medical images for their blurred measurements corrupted by Poisson noise and it's particularly simple algorithmic structure which implies straightforward implementation. Blind deconvolution is performed using RL algorithm in the literature (D. A. Fish et al 1995). Each iteration of RL method is used to guess the PSF and using this PSF image is restored. RL was developed from Bays' theorem. A blurred image can be reconstructed using a combination of RL algorithm and pyramid structure (D. a. Fish et al 1995). By using pyramid structure, the images with different frequency bands are generated. The combination of these two reduces the computational complexity and avoids the ringing effect. The purpose for the publicity of the RL algorithm that it was performance of maximum likelihood and it is apparent capability to produce a reconstructed image in good quality in the existence of high noise levels (M. Thakur & S. Datar 2014). RL provides the good estimation of the blurring function and gives the better PSNR within limited iterations.

5. Compare Between Various De-Blurring Technique

In this section, we represent the differentiation between various de-blurring techniques as bellow:

Table 1. Comparison Table

Method	Type of Blur	Performance	PSNR ratio
Weiner filter	Gaussian blur	Worst result	17.05
Regularized filter	Gaussian blur	Efficient	20.10
Lucy Richardson	Gaussian blur	Efficient	21.06
Handling outliers	Gaussian	Efficient	21.91
Hyperspectral (PCA)	Hyperspectral image blur	Efficient	22.34
MDF	Motion	Efficient	24.30
Motion density	Motion	Efficient	24.31
Blind deconvolution	Gaussian & motion	Efficient	26.78
Neural network	Gaussian & out-of-focus	Very Efficient	30.11
ASDS-AR	Gaussian	Very Efficient	31.20

6. Conclusions

This paper presents the review of state of art methods of image deblurring. Blind deconvolution jointly estimates the point spread function and clear image and we have no prior knowledge about PSF, types of blur, the presence of noise and the resultant image is better than any other technique but it is time consuming. We discuss non-blind deconvolution which includes three methods:

Wiener filtering, Richardson-Lucy algorithm, Regularized filter. In the presence of Gaussian noise, Wiener filter gives the best result and it is optimal in terms of mean square error. Richardson-Lucy gives better results with higher PSNR but it gives ringing artifacts with an increase in a number of iterations. The regularized filter is one of the better method to de-blurring when there is no noise in the image but when noise is present with blur, the Richardson-Lucy technique gives better performance. Many approaches use blur detection and blur classification as the blind estimation of PSF is difficult. Therefore, by classifying the blur we get the structure model of PSF and using this structure model of blur kernel we can easily estimate the true PSF. In general, blind deconvolution techniques show better results in comparison with non-blind deconvolution techniques.

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