Enhanced Method for Image Restoration using Spatial Domain

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Abstract- Image restoration is the process of reconstruction or recovering an image that has been corrupted by some degradation phenomenon. Degradation may occur due to motion blur, Gaussian blur, noise and camera mismatch. In this thesis corrupted image have been recovered using Modified Lucy Richardson algorithm in the presence of blur. The performance of this algorithm has been compared with Lucy Richardson algorithm. The performance comparison done on the based on peak signal-to-noise ratio (PSNR) and MSE(Mean Square Error). The result shows that Modified Lucy Richardson method is better than Lucy Richardson algorithm.

Keywords – Digital image processing, Blur, Modified Lucy Richardson, PSNR, MSE.

I. INTRODUCTION

Digital images[1] are electronic snapshots taken of a scene, which typically composed of picture elements in a grid formation known as pixels. Each pixel holds a quantized value that represents the tone at a specific point. Images are obtained in areas ranging from everyday photography to astronomy, remote sensing, medical imaging, and microscopy. Unfortunately all images end up more or less blurry. This is due to the fact that there is a lot of interference in the environment as well as in the camera. The blurring or degradation of an image can be caused by many factors such as movement during the capture process, using long exposure times, using wide angle lens etc. Image deblurring is used to make pictures sharp and useful by using mathematical model.

A. What is an Image

An image [3] is nothing but a huge collection of numbers known as pixels. In particular a gray image is an image in which the value of each pixel is a single sample, that is it carries only intensity information. So a pixel in a given image is just the intensity at that particular point. The pixel value is a number between 0 and 1 (both inclusive). 0 denotes the total absence (i.e. black) and 1 denotes the total presence (i.e. white).

B. Point Spread Function

The Point Spread Function describes the response of an imaging system to a point source or point object. Figure 1 shows an example of a PSF:

C. Degradation Model

The basic[1] unit of an image is called a pixel or image element i.e. the image is divided into very small blocks called pixels. An image can be defined as a two dimensional function I

\[ I = f(x,y) \] ....(1)
where x and y are spatial coordinates. (x,y) represents a pixel. I is the intensity or grey level value which is the amplitude of f at any point (x,y). If the values of the coordinates (spatial coordinates) and the amplitude are finite and discrete, then it is called digital image. The degradation process can be visualised with the following system.

\[ f(x,y) \xrightarrow{\text{Degradation Function} \ h(x,y)} g(x,y) \]

\[ n(x,y) \]

Figure 2. Degradation Model

The original input is a two-dimensional (2D) image f(x, y). This image is operated on by the system h(x,y) and after the addition of noise n(x, y). One can obtain the degraded image g(x,y). Digital image restoration may be viewed as a process in which we try to obtain an approximation to f(x, y). The blurred image can be described with the following equation.

\[ g(x,y) = h(x,y) * f(x,y) + n(x,y) \]………(2)

where h(x,y) is the degradation function, f(x,y) is the original image, the symbol * indicates convolution and \( \eta(x,y) \) is the additive noise.

As we know, taking convolution of two functions in spatial domain is equivalent to the product of the Fourier transforms of the two functions. So in the frequency domain we can represent equation (2) as

\[ G(u,v) = F(u,v)H(u,v) + N(u,v) \] ……..(3)

Where the terms in capital letters are the Fourier transforms of the corresponding terms in equation (2).

II. LITERATURE REVIEW

Dejee Singh et al.,(2013) [1] discussed that image blur is difficult to avoid in many situations and can often ruin a photograph. Image deblurring and restoration is necessary in digital image processing. Image deblurring is a process, which is used to make pictures sharp and useful by using mathematical model. Image deblurring have wide applications from consumer photography, e.g., remove motion blur due to camera shake, to radar imaging and tomography, e.g., remove the effect of imaging system response. There have been many methods that were proposed in this regard and in this paper we will examine different methods and techniques of deblurring. The analysis is done on the basis of performance, types of blur and PSNR (Peak Signal to Noise Ratio).

Dell'acqua F et al., (2010) [4], discussed that spherical deconvolution methods have been applied to diffusion MRI to improve diffusion tensor tractography results in brain regions with multiple fibre crossing. Recent developments, such as the introduction of non-negative constraints on the solution, allow a more accurate estimation of fibre orientations by reducing instability effects due to noise robustness. Standard convolution methods do not, however, adequately model the effects of partial volume from isotropic tissue, such as gray matter, or cerebrospinal fluid, which may degrade spherical deconvolution results. Here we use a newly developed spherical deconvolution algorithm based on an adaptive regularization (damped version of the Richardson-Lucy algorithm) to reduce isotropic partial volume effects. Results from both simulated and in vivo datasets show that, compared to a standard non-negative constrained algorithm, the damped Richardson-Lucy algorithm reduces spurious fibre orientations and preserves angular resolution of the main fibre orientations. These findings suggest that, in some brain regions, non-negative constraints alone may not be sufficient to reduce spurious fibre orientations. Considering both the speed of processing and the scan time required, this new method has the potential for better characterizing white matter anatomy and the integrity of pathological tissue.

Swati Sharma et al., (2013) [2], discussed that image restoration is the process of reconstruction or recovering an image that has been corrupted by some degradation phenomenon. Degradation may occur due to motion blur, Gaussian blur, noise and camera mismatch. In this paper corrupted image have been recovered using Modified Lucy
Richardson algorithm in the presence of Gaussian blur and motion blur. The performance of this algorithm has been compared with Wiener filter, Constraint Least Square method and Lucy Richardson algorithm. The performance comparison done on the based on peak signal-to-noise ratio (PSNR). The result shows that Modified Lucy Richardson method is better than Wiener filter, Constraint Least Square method and Lucy Richardson algorithm.

Guangmang Cui et al. (2014) [5], propose a modified non-blind Richardson–Lucy algorithm using adaptive reference maps as local constraint to reduce noise and ringing artifacts effectively. The deconvolution process can be divided into two stages. In the first deblurring stage, the reference map is estimated from the blurred image and an intermediate deblurred result is obtained. And then the adaptive reference map is updated according to both the blurred image and the deblurred result of the first stage to produce a more accurate edge description, which is very helpful to suppress the ringing around edges. Gaussian image prior is adopted as the regularization to improve the standard Richardson–Lucy algorithm. Experimental results show that the presented approach could suppress the negative ringing artifacts effectively as well as preserve the edge information, even if the blurred image contains rich textures.

Zongqing Zhao et al. (2007) [6], discussed that the Richardson–Lucy (RL) method of decoding used for x-rays code-aperture imaging (RAM) is proposed in this paper. The Wiener filter method cannot get the ideal result because of a lack of prior knowledge about the signal-noise ratio while the RL method gets a very good decoding result because it is based on the maximal probability estimation of the Poisson noise. We held experiments at the XingGuang II laser facility using an x-ray ring-code-microscope. The Wiener filtering method and the RL method are both used to decode the coded image. Compared with the Wiener filtering method, the RL method gets more ideal results, in good agreement with the pinhole image. This method can also be applied to penumbral imaging and other coded imaging techniques in ICF research.

III. EXPERIMENT AND RESULT

To see the qualitatively as well as quantitatively performance of the proposed algorithm, the experiment is conducted on digital image. The effectiveness of the approach has been justified using digital images. The results are computed qualitatively as well as quantitatively using quality measures.

The figures from Figure 3 to Figure 8 are the images of the proposed work which shows the different images which consists of original images and output images.
Figure 5. Restored image using improved deblurring technique

Figure 6. Restored image using Lucy-Richardson algorithm

Figure 7. Original and Restored images
Figure 8. shows the PSNR (Peak Signal to Noise Ratio) and MSE (Mean Square Error) of Lucy Richardson and Improved Deblurring Technique. This figure shows that PSNR increases and MSE decreases in Improved Deblurring technique as compared to Lucy Richardson Deblurring Technique.

IV. CONCLUSION

The proposed algorithm has high value of PSNR than the Lucy Richardson deblurring method in the presence of blur. Furthermore, the proposed algorithm has low value of mean square error than the Lucy Richardson deblurring method in the presence of blur.

In other words modified Lucy Richardson method restores the seriously blurred and noisy image in real life better than Lucy Richardson method.

REFERENCES


