IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 2, February 2016.
www.ijiset.com
ISSN 2348 – 7968

Image Restoration Using Lucy Richardson Algorithm For X-Ray Images

G.Suseela[1], S. Ahmed Basha[2] K.Prasasd Babu[3] K.Sudhakar[4]

[1] M.Tech DSCE 14G31D0605, JNTUA/SJCET/
Yemmiganur, Kurnool, Andhra Pradesh 518360, India

[2] Assistant Professor, ECE Department, JNTUA/SJCET/,
Yemmiganur, Kurnool, Andhra Pradesh 518360, India

[3] Assistant Professor, ECE Department, JNTUA/SJCET/,
Yemmiganur, Kurnool, Andhra Pradesh 518360, India

[4] Associate Professor & HOD,ECE Department, JNTUA/SJCET/,
Yemmiganur, Kurnool, Andhra Pradesh 518360, India

Abstract
Digital images restoration from their degraded measurement has always been a problem of great interest. A specific solution to the problem of image restoration is generally determined by the nature of degradation phenomena. So it is highly dependent on the nature of the noise present there. In this project Lucy Richardson algorithm (LRA) is implemented on the X-ray image using Matlab and restoration is processes is observed. LRA is a non blind technique of image restoration, used to restore a degraded image that has been degraded by a known PSF. It is an iterative procedure in which the pixels of the observed image are represented using the PSF. Image restoration is an emerging field of image processing in which the focus is on recovering an original image from a degraded image. The degraded image can be a result of a known degradation or unknown degradation. Hence image restoration can be defined as a process of recovering a sharp image from a degraded image which is blurred by a degradation function, commonly by a Point Spread Function (PSF). The Point Spread Function describes the response of an imaging system to a point source or point object
.

Keywords: *LRA, X ray images, Matlab, PSF.*

1. Introduction

Restoration of digital images from their degraded measurement has always been a problem of great interest. A specific solution to the problem of image restoration is generally determined by the nature of degradation phenomena. So it is highly dependent on the nature of the noise present there. Given the noise function, one can use the Richardson-Lucy Algorithm to restore the degraded image. This algorithm was introduced by W.H. Richardson (1972) and L.B. Lucy (1974).

An image 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).

Image restoration is based on the attempt to improve the quality of an image through knowledge of the physical process which led to its formation. The purpose of image restoration is to "compensate for" or "undo" defects which degrade an image. Degradation comes in many forms such as motion blur, noise, and camera mis-focus. In cases like motion blur, it is possible to come up with a very good estimate of the actual blurring function and "undo" the blur to restore the original image. In cases where the image is corrupted by noise, the best we may hope to do is to compensate for the degradation it caused. Image restoration differs from image enhancement in that the latter is concerned more with accentuation or extraction of image features rather than restoration of degradations. Image restoration problems can be quantified precisely, whereas enhancement criteria are difficult to represent mathematically. Image restoration started in 1950's. There are several application domain of image restoration like scientific exploration, legal investigations, film making and archrivals, image and video decoding and consumer photography. The main area of application is image reconstruction in radio astronomy, radar imaging and tomography.

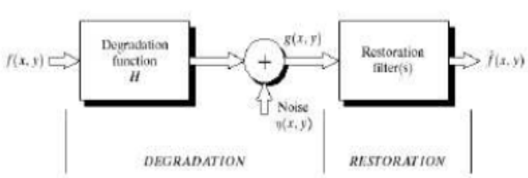
IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 2, February 2016.
www.ijiset.com
ISSN 2348 – 7968

IMAGE RESTORATION

Image restoration uses a priori knowledge of the degradation. It models the degradation and applies inverse process. It formulates and evaluates the objective criteria of goodness. The distortion can be modeled as noise or a degradation function. To restore an image from a noise model, different filters like median filter, homomorphic filters are used. To get rid of periodic noises, butterworth low pass filter, butterworth band reject filters and notch filters are used. To restore an image from linear degradation, inverse and pseudo inverse filtering, wiener filtering and blind de-convolution are used.

A simplified version for the image restoration process model is $y(i,j) = H\lfloor f(i,j)\rceil\rfloor + n(i,j)$

Where $y(i, j)$is the degraded image, $f(i, j)$ is the original image, H an operator that represents the degradation process $n(i, j)$ the external noise which is assumed to be image independent



Noise Models

In image processing there are different noise models available.

Gaussian Noise can be represented as

$$p(z) = \frac{1}{\sqrt{2\pi}\sigma} e^{\frac{(z-\mu)^2}{2\sigma^2}}$$

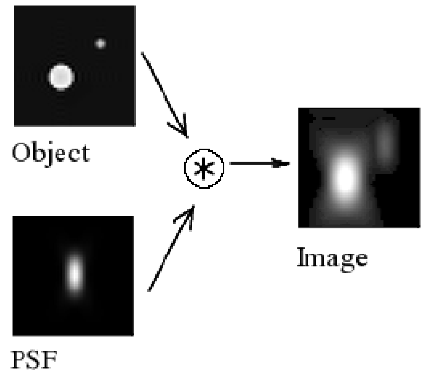
Rayleigh's noise can be represented as

$$p(z) = \frac{2}{b}(z-a)e^{\frac{(z-\mu)^2}{b}}$$

Salt and Pepper noise can be represented as

$$p(z) = P_a\delta(z-a) + P_b\delta(z-b)$$

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



The Blind Deconvolution Algorithm can be used effectively when no information about the distortion (blurring and noise) is known. The algorithm restores the image and the point-spread function (PSF) simultaneously. The accelerated, damped Richardson-Lucy algorithm is used in each iteration. Additional optical system (e.g. camera) characteristics can be used as input parameters that could help to improve the quality of the image restoration. Blind deconvolution is the problem of recovering a sharp version of an input blurry
image when the blur kernel is unknown. Mathematically

$$y = k \otimes x$$

Where x is a visually plausible sharp image, and k is a non negative blur kernel, whose support is small compared to the image size.

Richardson-Lucy Deconvolution Algorithm:

The Richardson–Lucy deconvolution algorithm has become popular in the fields of astronomy and medical imaging. Initially it was derived from Bayes's theorem in the early 1970's by Richardson and Lucy. Pixels in the observed image can be represented by

$$d_i = \sum_j p_{ij} u_j$$

$$u_j^{t+1} = u_j^t \sum_i \frac{d_i}{c_i} p_{ij}$$

$$u_j^{t+1} = u_j^t \left(\frac{d}{u^t \otimes p} \otimes \hat{p} \right)$$

ISSN 2348 – 7968

2. PSF& Lucy Richardson algorithm

The point spread function (PSF) describes the response of an imaging system to a point source or point object. A more general term for the PSF is a system's impulse response, the PSF being the impulse response of a *focused optical* system. The PSF in many contexts can be thought of as the extended blob in an image that represents an unresolved object. In functional terms it is the spatial domain version of the transfer function of the imaging system. It is a useful concept in Fourier optics, astronomical imaging, medical imaging, electron microscopy and other imaging techniques such as 3D microscopy (like in confocal laser scanning microscopy) and fluorescence microscopy. The degree of spreading (blurring) of the point object is a measure for the quality of an imaging system. In non-coherent imaging systems such as fluorescent microscopes, telescopes or optical microscopes, the image formation process is linear in power and described by linear system theory. This means that when two objects A and B are imaged simultaneously, the result is equal to the sum of the independently imaged objects. In other words: the imaging of A is unaffected by the imaging of B and *vice versa*, owing to the non-interacting property of photons. The image of a complex object can then be seen as a convolution of the true object and the PSF. However, when the detected light is coherent, image formation is linear in the complex field. Recording the intensity image then can lead to cancellations or other non-linear effects.
The steps involved in Lucy Richardson and PSF are as shown below

Step 1: Read Image

Step 2: Simulate a Blur and Noise

Step 3: Restore the Blurred and Noisy Image

Step 4: Iterate to Explore the Restoration

Step 5: Control Noise Amplification by Damping

Step 6: Create Sample Image

Step 7: Simulate a Blur

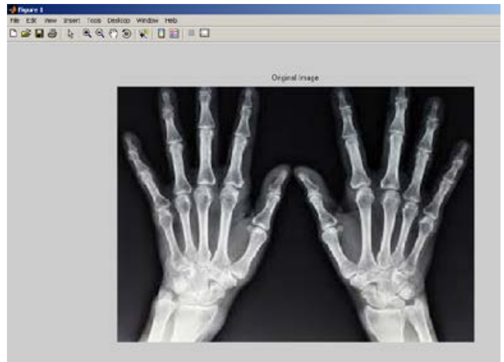
Step 8: Provide the WEIGHT Array

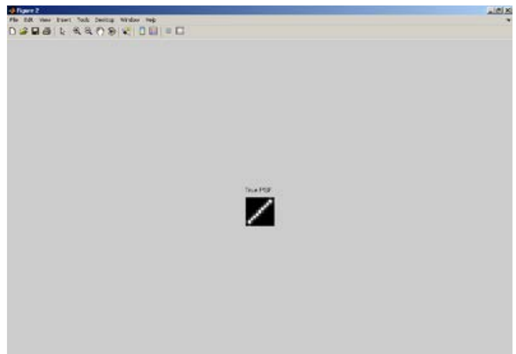
Step 9: Provide a finer-sampled PSF

.

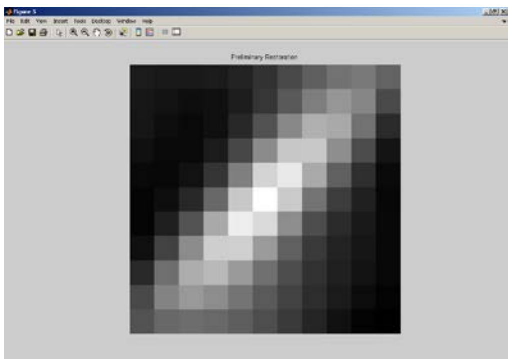
3. Results

Image deblurring outputs





ISSN 2348 – 7968



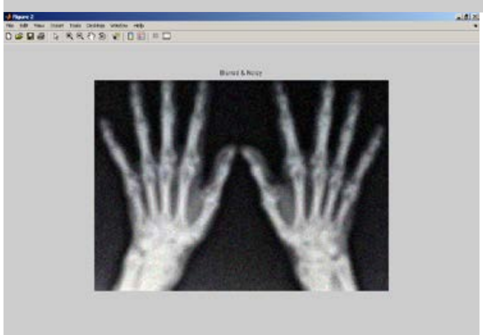


Fig. 1 Images of X-ray deblurring.

LUCY RICHARDSON algorithm outputs

IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 2, February 2016.
www.ijiset.com
ISSN 2348 – 7968

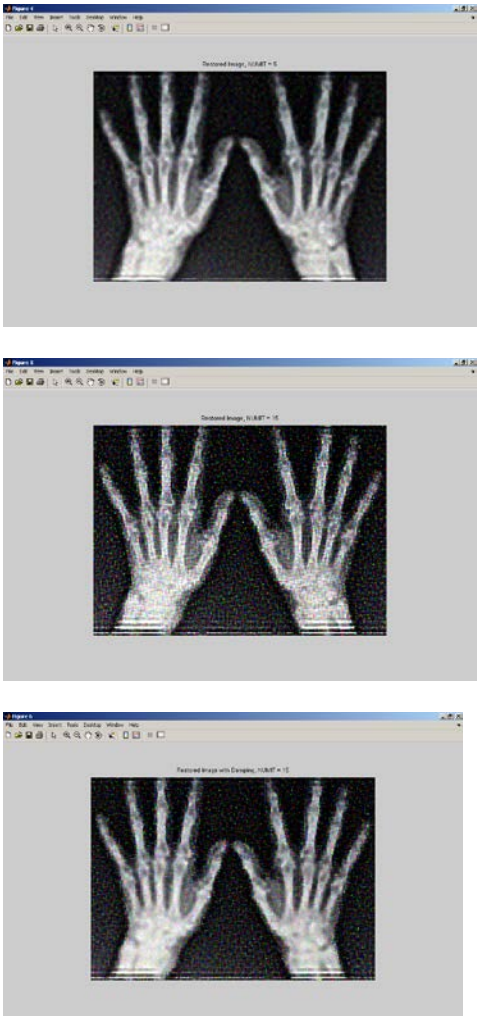
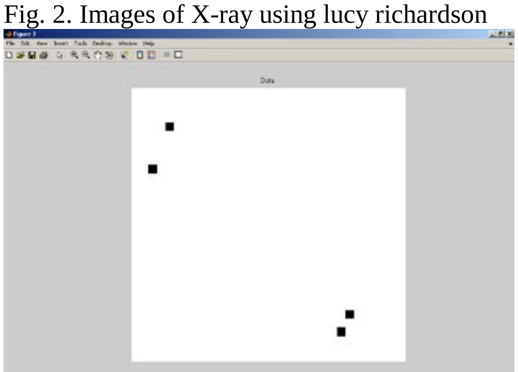
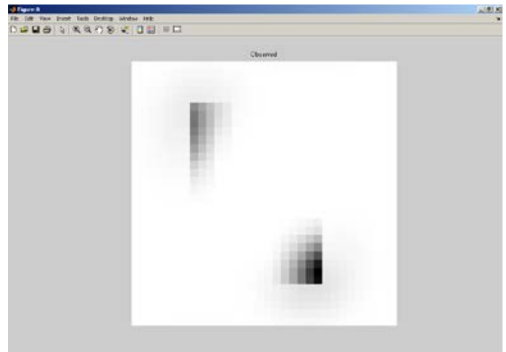
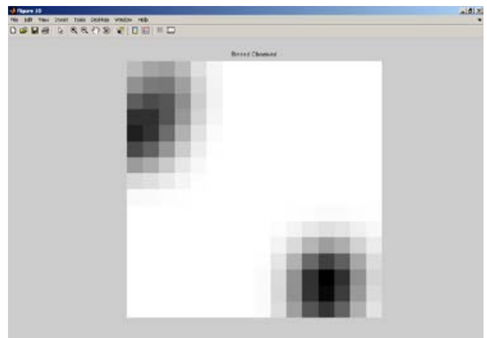
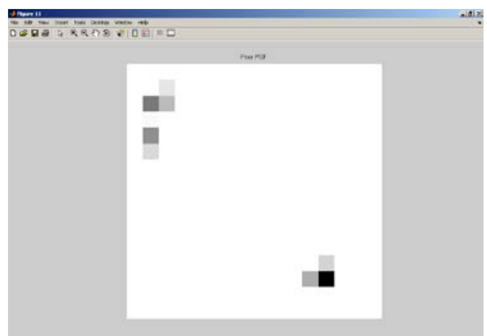


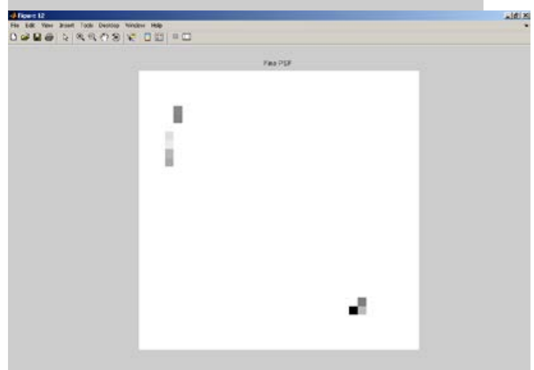
Fig. 2. Images of X-ray using lucy richardson











ISSN 2348 – 7968

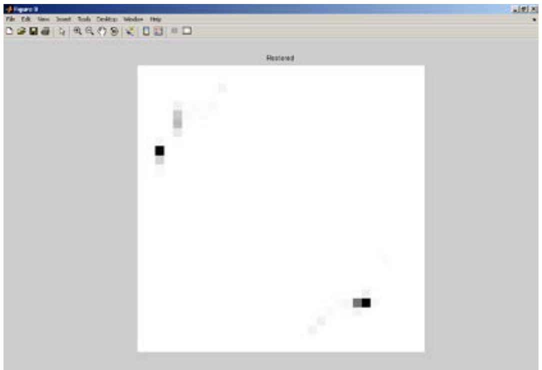


Fig. 3 PSF outputs.

4. Conclusions

The results show how to use the Lucy-Richardson algorithm to deblur images. It can be used effectively when the point-spread function PSF (blurring operator) is known, but little or no information is available for the noise. The blurred and noisy image is restored by the iterative, accelerated, damped Lucy-Richardson algorithm.

References

[1] Amandeep Kaur, Vinay Chopra, “A comparative study and analysis of image restoration techniques using different image formats,” International Journal of Science and Emerging Technologies with latest trends, 2, 1, pp. 7-14, 2012.

[2] M.R. Banham and A.K. Katsaggelos,"Digital Image Restoration,"IEEE Signal Processing Magazine, Vol. 14, No.2, pp.24-41, March 1997.

[3] M. Ben-Ezra and S.K. Nayar, “Motion-based motion deblurring,”IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 26, No. 6, pp. 689-698, June 2004.

[4] X. Jiang, D. C. Cheng, et. Al. “Motion Deblurring,” University of Muenster, Department of Mathematics and Computer Science, 2005.

[5] R. C. Gonzalez and R. E. Woods, “Digital Image Processing Second Edition,”Prentice-Hall India, 2007. [3] A. Name, "Dissertation Title", M.S.(or Ph.D.) thesis, Department, University, City, Country, Year.

[6] G. Li, Y. Ito, et. Al., “A discrete wavelet transform based recoverable image processing for privacy protection,” IEEE International Conference on Image Processing, pp. 1372-1375, October 2008.

[7] M. S. Hsieh, “Perceptual Copyright Protection using multiresolution Wavelet Based Watermarking and Fuzzy Logic,”International Journal of Artificial Intelligence & Applications, Vol.1, No.3, July 2010.

[8] J. M. Parmar and S. A. Patil,”Performance Evaluation and Comparison of Modified Denoising Method and the Local Adaptive Wavelet Image Denoising Method,” International Conference on Intelligent Systems and Signal Processing, pp. 101-105, March 2013.

[9] M. Bertero and P. Boccacci, “A simple method for the reduction of boundary effects in the Richardson-Lucy approach to image deconvolution,”Astronomy and Astrophysics,Vol. 437,pp. 369-374, July 2005.