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A Review: A Novel Algorithm for Blurred Image Restoration in the field of Medical Imaging

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Abstract: Image restoration deals with bringing back the degraded image to its original state i.e. it helps to restore the degraded image into more sharp and clear image. Restoration of medical images is the demand of the hour as such images suffer from distortions like noise and blur. X-ray images play a vital role in dealing with the detection of various diseases in patients and they face the problem of Gaussian noise and motion blur. Hence their restoration is must which can be done with the help of image restoration techniques. In this paper, two popular restoration techniques viz. LRA and BID are applied and analyzed in the recovery of X-ray images

Keywords: BID, Degradation model, Restoration model Medical Images, X-ray images, LRA, PSF.

I. INTRODUCTION

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) [1][2].

A. Process of Image Restoration

The process of image restoration includes two sub processes. The first part deals with degrading the quality of the image by adding blur and noise to an image and the second part deals with removing noise and blur from the degraded image and recovering the original image. These two sub processes are named as degradation model and restoration model respectively. Both these are discussed below.

Degradation model: In degradation model, the image is blurred using degradation function and additive noise. The following Figure 1 represents the structure of degradation model [3].

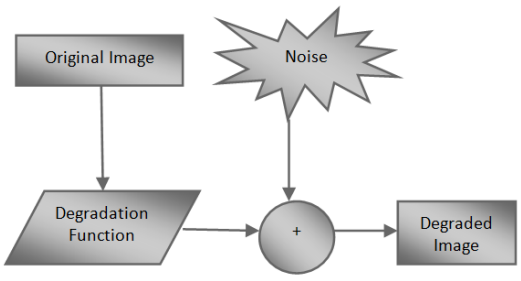

Fig.1 Degradation Model

The degraded image can be described by the following equation:

$$g = h * f + n \quad (1)$$

In equation (1), g is the degraded image, h is the degradation function, f is an original image and n is the additive noise.

Restoration model: In Restoration model, the degraded image is reconstructed using restoration filters. In this process noise and blur factor is removed and we get an estimate of the original image as a result of restoration. The closer the estimated image is to the original image the more efficient is our restoration filter. Figure 2 represents the structure of restoration model [3].

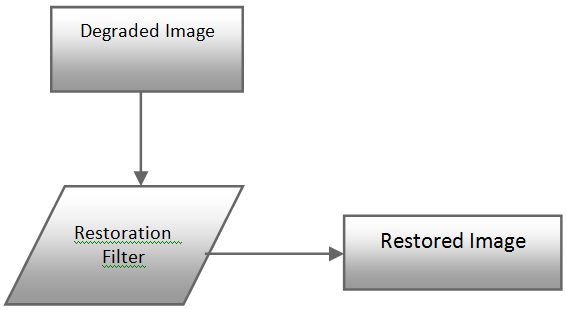

Fig.2 Restoration Model

B. Restoration techniques

There are numerous techniques and algorithms available for Image restoration. Each technique has its own features. Broadly, Image restoration techniques are classified into two categories which are shown in Figure 3 below:

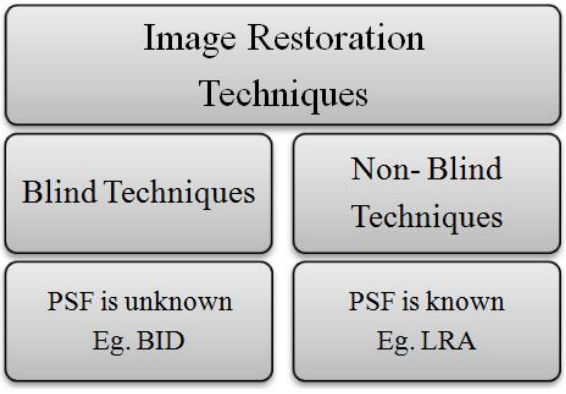

Fig. 3: Image Restoration Techniques

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Following is a brief introduction of both the image restoration techniques [3][4].

Blind Image Restoration: This Technique allows the reconstruction of original images from degraded images even when we have very little or no knowledge about PSF. Blind Image Deconvolution (BID) is an algorithm of this type. These techniques are more difficult to implement and are more complicated as compared to other category [5].

Non-Blind Restoration: This Technique helps in the reconstruction of original images from degraded images when we know that how image was degraded i.e. we have a knowledge about PSF. LRA i.e. Deconvolution using Lucy Richardson Algorithm is one among various non-blind techniques.

II. LUCY RICHARDSON ALGORITHM

LRA stands for Lucy Richardson Algorithm which is used for image restoration. It 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 and the latent image as follows [6]:

$$di = \Sigma\, pij\, uj \qquad (2)$$

In equation (2), di is the observed value at pixel position „i", pij is the PSF , the fraction of light coming from true location „j" that is observed at position „i" , uj is the latent image pixel value at location „j" . The main objective is to compute the most likely „uj" in the presence of observed di and known PSF pij as follows:

$$u_j^{(t+1)} = u_j^{(t)} \sum_i \frac{d_i}{c_i} p_{ij} \qquad (3)$$

Where,

$$c_i = \sum_j p_{ij}\, u_j^{(t)} \qquad (4)$$

The Lucy-Richardson Algorithm is a well-known iterative method for the deconvolution of images convolved with a known point spread function. It is derived from a statistical point of view as it converges to the maximum-likelihood solution under the condition that the data follow a Poisson distribution. This assumption holds true for images detected by a digital camera. However, there are images not following a Poisson but rather a non central chi-square distribution. Here an adaption of the Lucy-Richardson algorithm to be used for data following this probability distribution is shown. Its application to simulated and real data from an imaging radar sensor shows its various advantages of the original algorithm. Lucy Richardson is a well known algorithm used for restoring the degraded images. It is used when knowledge about the sources which have actually degraded the original image is known. It gives us an estimate of the original image. [6]

III. BLIND IMAGE DECONVOLUTION

BID is a Blind technique of image restoration which restores the degraded image that is blurred by an unknown PSF. It is a deconvolution technique that permits recovery of the target image from a single or set of blurred images in the presence of a poorly determined or unknown PSF [7].

In this technique firstly, we have to make an estimate of the blurring operator i.e. PSF and then using that estimate we have to deblur the image. This method can be performed iteratively as well as non-iteratively. In iterative approach, each iteration improves the estimation of the PSF and by using that estimated PSF we can improve the resultant image repeatedly by bringing it closer to the original image. In non-iterative approach one application of the algorithm based on exterior information extracts the PSF and this extracted PSF is used to restore the original image from the degraded one[5][9].

IV. MEDICAL IMAGE RESTORATION

Image restoration techniques are used in a various areas. Their applications are very vast ranging from simple images to complex medical images. They can be applied to restore images from astronomical field like radar images, images from medical field, satellite images that show vegetation or those satellite images that focus on forest areas and many more.

In this paper, medical image restoration is focused because they are of utmost importance these days and their restoration is very complicated.

A. Medical Images

Medical Images are used to detect a number of diseases which cannot be detected otherwise. But these medical images may be contaminated with noise or blur which makes the detection of the disease difficult for doctors. So restoration of such contaminated medical images is must for the well being of the common people.

There are a number of medical images some of which are X-ray Images, Ultrasound Images, MRI, endoscopic images, CT scan Images, Mammographic images which are useful in the detection of one ailment or the other.

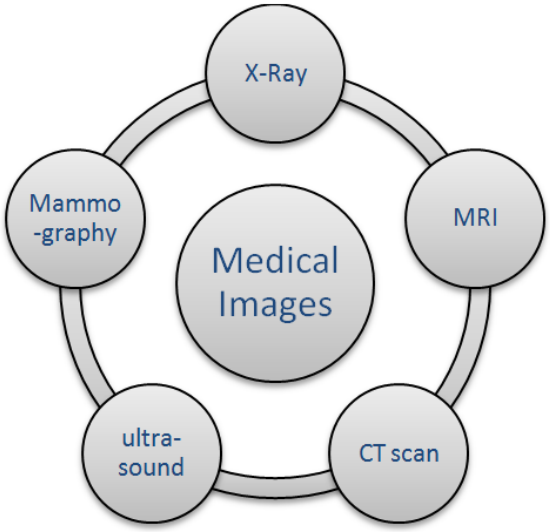

Fig. 4: Medical Images

B. X-ray Images

X-ray imaging is a popular and most commonly used method for diagnosing the internal bone structures of the body. It is used to find orthopaedic damage, tumours, pneumonias, foreign objects, etc.

An X-ray beam is passed through the body where a portion of the X-rays are either absorbed or scattered by the internal structures, and the remaining X-ray pattern is transmitted to a detector (e.g., film or a computer screen) for recording or further processing by a computer. These exams differ in their purpose. Sometimes these images get degraded because of some reasons which can be restored with help of various algorithms.

C. X-ray Image Restoration

X-ray images are very beneficial now days for the detection of numerous diseases. Unfortunately, X-ray images appear low image quality caused by fairly low spatial resolution and the presence of noise. X-ray images also suffer from noise and blur so they also need restoration in order to remove blur and noise. Hence restoration of X-ray images is very challenging.

Both the restoration techniques discussed in Section-II can be applied for the restoration of X-ray images. X-ray images basically suffer from motion blur and some kind of noise like Gaussian noise. BID algorithm can successfully restore the degraded X-ray images but LRA have some problems while removing the effects of noise as well as blur from the X-ray images.

V. CONCLUSION AND FUTURE SCOPE

To conclude restoration of medical images like X-ray is very crucial and sensitive matter. Hence their restoration must be done to maximum possible level. The performance of BID technique while recovering X-ray images is commendable but LRA needs a lot of improvement. The ringing effects present at the edges of the restored image due to the process of deconvolution need improvement.

Future work of this paper is to develop and build improved LRA which will give better performance than BID.

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