© 2017 IJEDR | Volume 5, Issue 1 | ISSN: 2321-9939

Image Restoration Using Blur Invariants In Wavelet Transform

[1]N.Gopinath Thangadurai, [2]Mr.X. Jeevan Patrick
[1]Master of Engineering Final year , [2]Assistant Professor,
Department of Communication Systems,
R.V.S Educational Trust's Group of Institutions,

***Abstract*-Image restoration is an important issue in high-level image processing. Images are often degraded during the data acquisition process. The degradation may involve blurring, information loss due to sampling, quantization effects, and various sources of noise. The purpose of image restoration is to estimate the original image from the degraded data. It is widely used in various fields of applications, such as medical imaging, astronomical imaging, remote sensing, microscopy imaging, photography deblurring, and forensic science, etc. Images are produced to record or display useful information. Due to imperfections in the imaging and capturing process, however, the recorded image invariably represents a degraded version of the original scene. The undoing of these an imperfection is crucial to many of the subsequent image processing tasks. There exists a wide range of different degradations, which are to be taken into account, for instance noise, geometrical degradations (pincushion distortion), illumination and color imperfections (under/overexposure, saturation), and blur. Blurring is a form of bandwidth reduction of an ideal image owing to the imperfect image formation process. It can be caused by relative motion between the camera and the original scene, or by an optical system that is out of focus.**

I. INTRODUCTION

The field of digital image restoration has a quite long history that began in the 1950s with the space program. However the images were obtained under big technical difficulties such as vibrations, bad pointing, motion due to spinning, etc. These difficulties resulted in most cases, in medium to large degradations that could be scientifically and economically denying. The need to retrieve as much information as possible from such degraded images was the aim of the early efforts to adapt the one-dimensional signal processing algorithms to images, creating a new field that is today known as "Digital Image Restoration and Reconstruction".

Where f is the original image, g is a degraded/noisy version of the original image and $\hat{f}$ is a restoredversion. In many applications (e.g., satelliteimaging, medicalimaging, astronomicalimaging, poor-quality family portraits) the imaging system introduces a slight distortion.

Digital image restoration is a field of engineering that deals with methods used to recover an original picture from degraded observations. Image restoration techniques aim at reversing the degradation undergone by an image to recover the true image. Image may be corrupted by degradation such as linear frequency distortion, noise, and blocking artifacts.

The degradation consists of two distinct processes:-the deterministic blur and the random noise. The blur may be due to a no of reasons, such as motion, defocusing and atmospheric turbulence. The noise may originate in the image-formation process, the transmission process, or a combination of them. Most restoration techniques model the degradation process and attempt to apply an inverse procedure to obtain an approximation of the original image. Many image restoration algorithms have their roots in well-developed areas of mathematics such as estimation theory, the solution of ill-posed problems, linear algebra and numerical analysis. Iterative image restoration techniques often attempt to restore an image linearly or non-linearly by minimizing some measures of degradation such as maximum likelihood, constrained least square, etc. Blind restoration techniques attempt to solve the restoration problem without knowing the blurring function. No gentral theory of image restoration has yet evolved; however, some solutions have been developed for linear and planer invariant systems.

II. IMAGE REGISTRATION USING WAVELET DOMAIN BLUR INVARIANTS

The imaging condition is not always perfect, particularly when there is no control on the subject. People in surveillance photos and body parts in medical images are real-world subjects that are not ideally controllable when acquiring images. Environmental situations might also have a negative effect on the quality of images, e.g., weather condition and long distances between camera and subject can deteriorate images. Deteriorations in images are basically of two types, i.e., geometric distortions and radiometric degradations. The first type includes distortions such as translation, scaling, and rotation. The second type includes generally introduced to images due to the movement of the subject, unfocused camera, and non-ideal image-capturing environment.

Radiometric degradation is a common problem in the image acquisition part of many applications. The term image acquisition refers to the process of capturing real-world images and storing them into a computer. To tackle this problem, different blur-invariant descriptors are developed, which are either in the spatial domain or based on the properties available in the Fourier domain. (Makaremi.I 2010)

Blur invariant descriptors are developed in the wavelet domain. The main advantage of this domain provides which are invariant to centrally symmetric blur. The wavelet domain blur invariants provide the different alternatives that exist for wavelet functions and the benefit of analyzing signals at different scales in the wavelet domain.

*A.*BLUR INVARIANTS IN THE WAVELET DOMAIN

Blur invariants are developed from wavelet transform. It is based on following steps. First, it is shown how the blur operator represents itself in the wavelet domain. Afterward, ordinary and central moments are developed in that domain, and the relationship between the moments of the wavelet transform of a signal and the moments of the signal and the wavelet function, and the relation between the moments of the wavelet transform of a blurred signal and those of the wavelet transform of the original signal and the blur system are extracted. In addition, wavelet-domain blur invariants (WDBIs) are proposed and proven in this section. This section includes a discussion on the discriminative power of the proposed invariants as well:

B. 1 BLUR IN THE WAVELET DOMAIN

The general model that is commonly used for the observed signal is,

$$y(u)=Bx(u)+n(u) \qquad (3.1)$$

In this model, *y* is observed signal; *x* and *n* are the actual signal and noise, respectively; and *B* is the degradation operator. If it is assumed that *B* is linear and space invariant, for 2-D discrete signal, the general model can be simplified to,

$$y[n_1,n_2]=b*x[n_1,n_2] \qquad (3.2)$$

where'*' denotes the convolution, and *b* is the point spread function of the system.

The wavelet transform of a blurred image with wavelet function Ψ_L is,

$$\overset{\Psi_L}{W}\, y[n_1,n_2]=\overline{\Psi}*y[n_1,n_2] \qquad (3.3)$$

Substitute *y [n*1, *n*2*]* = *b** *x* [n_1, n_2] in above equation, we get

$$\overset{\Psi_L}{W} y[n_1,n_2]=b*\overset{\Psi_L}{W} x[n_1,n_2] \qquad (3.4)$$

Equation 3.4 implies that the wavelet transform of the blurred signal y is the convolution of blur system b with the wavelet transform of the original signal x. (Makaremi. I 2010)

3.2.2 Moments in the Wavelet Domain

It can be shown that the ordinary moment of order (p+q) of $\overset{\Psi_L}{W}x$ is (3.5

If Ψ_L has $M_{\Psi_L^1}$ and $M_{\Psi_L^2}$ vanishing moments on the first and second dimensions, respectively $m_{i,j}^{\Psi_L}$ in (3.3) will be zero when $i<M_{\Psi_L^1}$ or $j<M_{\Psi_L^2}$ .This forces the moments of $\overset{\Psi_L}{W}x$ to zero if $p<M_{\Psi_L^1}$ or $q<M_{\Psi_L^2}$ .considering this should be employed in order to calculate the central moments of the wavelet transform of signals. Therefore, the central moment of Order (p+q) of $\overset{\Psi_L}{W}y$ can be extracted as

$$\mu_{p,q}^{W_y^{\Psi_L}}=\sum_{i=0}^{p}\sum_{j=0}^{q}\binom{p}{i}\binom{q}{j}\mu_{i,j}^{W_x^{\Psi_L}}\mu_{p-i,q-j}^{b} \qquad (3.6)$$

Since $\mu_{i,j}^{W_x^{\Psi_L}}$ is zero for $i<M_{\Psi_L^1}$ or $j<M_{\Psi_L^2}$,p and q should be equal to or greater than $M_{\Psi_L^1}$ and $M_{\Psi_L^2}$,respectively.

Therefore by defining $r+M_{\Psi_L^2}=p$, $s+M_{\Psi_L^2}=q$, $\mu'_{r,s}=\mu_{p,q}$, and $\binom{a}{b}_M=\binom{a+M}{b+M}$, eqn (3.6) is modified

to $$\mu'^{W_y^{\Psi_L}}_{r,s}=\sum_{i=0}^{r}\sum_{j=0}^{s}\binom{r}{i}_{M_{\Psi_L^1}}\binom{s}{j}_{M_{\Psi_L^2}}\mu'^{W_x^{\Psi_L}}_{i,j}\mu^{b}_{r-i,s-j}$$

IV. DISCRIMINATIVE POWER

It is used to provide would not have null space for centrally symmetric signals which is the problem that the conventional invariants have, and although the chance of occurrence is low,it subsequently reduces their discriminative power. (Makaremi.I 2010)

VI.BLUR INVARIANTS IN IMAGE REGISTRATION

Invariants are used in the image registration. The invariants are constructed using Daubuchies and bspline wavelet function. The Daubechies wavelets are a family of orthogonal waveletsdefining a discrete wavelet transform and characterized by a maximal number of vanishing moments for some given support. Daubechies has shown that it is impossible to obtain an orthonormal and compactly supported wavelet that is either symmetric or anti symmetric except for haar wavelets.

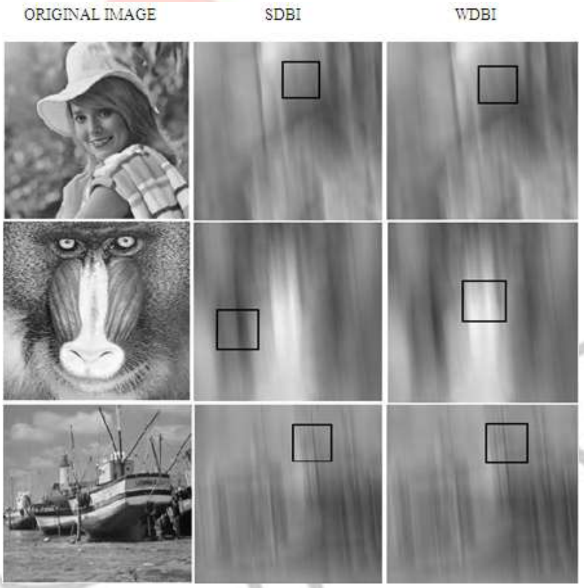
Fig 3.2 Original Image

Fig 3.3 Degraded Image due to Motion Blur

Fig 3.4 Template Image

Fig 3.5 Registered Image by SDBI

Fig 3.6 Registered Image by WDBI



In this experiment, the real world degraded images are gained by own ability and the invariants are utilized by registration. The spatial domain blur invariants are used for a comparison of wavelet domain blur invariants. In this experiment Daubuchies wavelet function are excited and moments of order up to 10(r + s = 10) is chosen. An original image of size 256x256 and its degraded image affected by motion blur are taken into account as shown in the Figure 3.2 and Figure 3.3 respectively. Template image of size 68 x 64 is taken from the degraded image which is shown in the Figure 3.4. The template image is matched with the blur image by the similarities. After using similarity the image is registered by SDBI and WDBI.

A. PSNR

B. This PSNR is often used as a quality measurement between the original and a reconstructed image. Table 5.1 and Table 5.2 shows the PSNR values of SDBI and WDBI Restored image used for different template image using blind deconvolution algorithm respectively.

C. $$\mathrm{PSNR} = 10\log\left(\frac{255^2}{\mathrm{MSE}}\right) \qquad (5.1)$$

D. Where, MSE=Mean Square Error value. It is given by

E. $$\mathrm{MSE} = \left(\frac{1}{\mathrm{M}\times\mathrm{N}}\right)\sum_{i=1}^{M}\sum_{j=1}^{N}(X_{ij} - Y_{ij})^2 \qquad (5.2)$$

F. Where,

G. M×N=Size of the Blur Image,

H. $X_{ij,} Y_{ij}$ =pixel values of the original image and Blur image respectively.

Template Image of size(97X96)	Spatial Domain	Wavelet Domain	
		Using Daubechies Function	Using B-Spline Function
Lena	19.9137	21.6663	26.5944
Boat	16.4451	19.2594	24.9335
Group image	20.3878	22.1617	27.6022
Elaine	22.5224	24.7847	30.0970
Barbara	26.8935	28.8421	34.2108

B. INPUT IMAGE

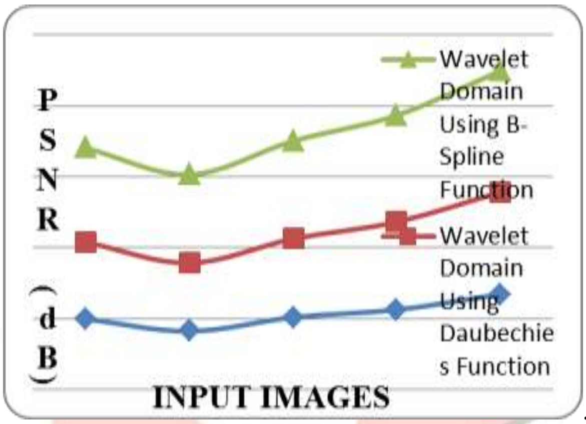


FIG:Comparison Graph of Restoration Results in PSNR (dB) of SDBI and WDBI for template image of size 97x96

VI.CONCLUSION

In this proposed work, new set of blur invariant descriptors has been proposed. These descriptors have been advanced in the wavelet domain 2D and 3D images to be invariant to centrally symmetric blur. First, Image registration was done using wavelet domain blur invariants. The method uses Daubuchies and Bspline wavelet function which was used to construct blur invariants. The template image was chosen from the degraded image. The template images and the original images were matched with its similarities.This wavelet domain blur invariants accurately register an image compared to spatial domain blur invariants which might result in misfocus registration of an image. Despite of the presence of harmful blurs, the image registration has been correctly performed. The experiments carried out by using SDBIs, were failed in some of the image registration. Then regression based process is done about to produce an image convolved with near diffraction limited PSF, which can be shown as blur invariant. Eventually a blind deconvolution algorithm is carried out to remove the diffraction limited blur from fused image the final output. Finally, image was restored by using blind deconvolution algorithm and also PSNR values are calculated. Hence the image quality is improved.

REFERENCES

[1] Barbara Zitova, Jan Flusser., (2003) ‘Image registration methods: a survey’, Image and Vision Computing 21, pp. 977–1000.

[2] Bentoutou Y, Taleb N, Kpalma K, and Ronsin J., (2005) “An automatic image registration for applications in remote sensing,” IEEE Trans.Geoscience Remote Sensing., vol. 43, no. 9, pp. 2127–2137.

[3] Flusser J, Suk T, and Zitov B., (2009) ’Moments and Moment Invariants in Pattern Recognition’, Hoboken, NJ: Wiley first edition.

[4] Flusser J, Suk T, and Saic S., (1995) ‘Image features invariant with respect to blur’, Pattern Recognition., vol. 28, no. 11, pp. 1723–1732.

[5] Flusser J, Suk T, and Saic S.,(1996) ‘Recognition of blurred images by the method of Moments’, IEEE Trans. Image Process., vol. 5, no. 3, pp. 533–538.

[6] Flusser J and Suk T.,(1998)‘Degraded image analysis: An invariant approach’, IEEE Trans. Pattern Analysis Machine Intelligence., vol. 20, no. 6, pp.590–603.

[7] Flusser J and Suk T.,(1997)'Classification of degraded signals by the method of invariants', Signal Processing, vol. 60, no. 2, pp. 243–249.

[8] Flusser J and Zitova B.,(1999)'Combined invariants to linear filtering and rotation', International journalPattern Recognition Artificial Intelligence., vol. 13, no. 8, pp.1123–1136.

[9] Flusser J., Boldys J., and Zitova B.,(2003) 'Moment forms invariant to rotation and blur in arbitrary number of dimensions', IEEETrans. Pattern Analysis Machine Intelligence vol. 25, no. 2, pp. 234–246.

[10] Metari S and Deschenes F.,(2008)'New classes of radiometric and combined radiometric-geometric invariant descriptors', IEEE Trans. ImageProcess., vol. 17, no. 6, pp. 991–1006.

[11] Mallat S.,(1999) A Wavelet Tour of Signal Processing, (Wavelet Analysis & Its Applications), New York: Academic, second edition.