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A Review on: Comparative study of motion blurred images using different filters

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Abstract*— Motion blur can significantly degrade the quality of an image. The images become blurred due to camera movements, object movements or displacements of pixels. This paper attempts to undertake the study of motion blurred images by using three types of techniques of deblurring images as median filter, wieners filter and curvelet transform and accuracy measurement using peak signal to noise ratio and mean square error. Curvelet transformation is a multi-scale transformation technique which is most suitable for the objects with curves.

***Keywords*— blur, point spread function, Median filter, wiener filters, curve let transform, MSE and PSNR.**

I. Introduction

MOTION blur is the result of the relative motion between the camera and the scene during the integration time of the image. Motion blur can be used for aesthetic purposes, such as emphasizing the dynamic nature of a scene. It has also been used to obtain motion and scene 3D structure information. Motion blur has also been also used in computer graphics to create more realistic images which are pleasing to the eye. Several representations and models for motion blur in human and machine vision have been proposed. Very often, motion blur is simply an undesired effect. It has plagued photography since its early days and is still considered to be an effect that can significantly degrade image quality. Every motion blurred image tends to be uniquely blurred. This makes the problem of motion deblurring hard[1].When a photograph is taken of a fast moving object, motion blur can cause significant degradation of the image .This is caused by the movement of the object relative to the sensor in the camera during the time the shutter is open. Both the object moving and camera shake contribute to this blurring. Image deblurring is usually the first process that is used in the analysis of digital images. In any image denoising technique it is very important that the denoising process should not have any blurring effect on the image, and makes no changes on the preserving of images to image edges[2].

Digital images have applications in daily life, such as digital cameras, HDTV (High Definition Television) and in areas of research and technology including GIS(Geo-graphical Information System). Datasets collected by image sensors are generally contaminated by noise and noise can be introduced by transmission errors and compression. The purpose of image denoising is to recover an image that is cleaner than its noisy observation. Thus, noise reduction is an important technology in image analysis and the first step to be taken before images are analysed[3].The restoration image is very important process in the image processing to restore the image by using the image processing techniques to easily understand this image without any artifacts errors[4].

Digital image acquisition and processing techniques plays very important role in current-day digital images. digital images are generally of low contrast and they often have a complex type of noise due to various acquisitions, transmission storage and display devices and also because of application of different types of quantization, reconstruction and enhancement algorithms

Digital images are contaminated with Gaussian noise and blur which are some of the major sources of image quality degradation. Image restoration is the removal or reduction of degradations that are incurred while the image is being obtained. Degradation comes from blurring as well as noise due to electronic and photometric sources. A noise is introduced in the transmission medium due to a noisy channel, errors during the measurement process and during quantization of the data for digital storage. Image denoising finds applications in medical imaging where the physical requirements for high quality imaging are needed for analysing images of unique events. Gaussian noise significantly degrades the image quality and hence, makes it more difficult for the observer to discriminate fine detail of the images in diagnostic examinations. The standard model of amplifier noise is additive, Gaussian, independent at each pixel and independent of the signal intensity. Additive white Gaussian noise is a channel model in which the only impairment to communication is a linear addition of wideband or white noise with a constant spectral density and a Gaussian distribution of amplitude. Blurring limits visibility of detail. There is some blurring in all digital images. There are three specific effects of blurring in digital imaging reduced visibility of detail, image unsharpness and reduced spatial resolution. Deblurring plays an important role in signal processing. An image is often corrupted by noise in its acquisition or transmission. The aim of deblurring is to remove the noise and blur from the corrupted image and retain as much as possible the important information. Curvelet transform is a multiscale geometric wavelet transforms, can represent edges and curve-singularities much more efficiently than traditional wavelet. Curvelet combines multiscale analysis & geometrical ideas to achieve the optimal rate of convergence by simple thresholding. In soft thresholding scheme, if the absolute value of the input X is less than or equal to λ then the output is forced to zero. In the hard thresholding scheme, the input is kept if it is greater than the threshold λ, otherwise it is zero. The hard thresholding procedure removes the noise by thresholding only the wavelet coefficients of the detailed sub band, while keeping the low-resolution coefficients unaltered. Median filter follows the moving window principle and uses 3×3, 5×5 or 7×7 window. The median of window is calculated and the center pixel value of the window is replaced with that value. This paper presents the image de-blurring and de-noising on digital images embedded in Gaussian noise and motion blur based on curvelet transformation using median filter. The performance assessment parameters used are Peak-signal-to-noise-ratio (PSNR) and Mean square error (MSE) [5].The assumption of Gaussian noise is a fundamental element of common image deblurring algorithms [6].

1.1. Blurring
Blur is unsharp image area caused by camera or subject movement, inaccurate focusing, or the use of an aperture that gives shallow depth of field. The Blur effects are filters that smooth transitions and decrease contrast by averaging the pixels next to hard edges of defined lines and areas where there are significant color transition.

1.1.2. Blurring Types
In digital image there are 3 common types of Blur effects:

1) Average Blur
The Average blur is one of several tools you can use to remove noise and specks in an image. Use it when noise is present over the entire image. This type of blurring can be distribution in horizontal and vertical direction and can be circular averaging by radius R which is evaluated by the formula:
R =√ g2 + f2
Where: g is the horizontal size blurring direction and f is vertical blurring size direction and R is the radius size of the circular average blurring.

2) Gaussian Blur
The Gaussian Blur effect is a filter that blends a specific number of pixels incrementally, following a bell-shaped curve. The blurring is dense in the centre and feathers at the edge. Apply Gaussian Blur to an image when you want more control over the Blur effect.

3) Motion Blur
The Motion Blur effect is a filter that makes the image appear to be moving by adding a blur in a specific direction. The motion can be controlled by angle or direction (0 to 360 degrees or –90 to +90) and/or by distance or intensity in pixels (0 to 999), based on the software used.

II. Deblurring

2.1. Deblurring Model
A blurred or degraded image can be approximately described by this equation:
g = PSF*f + N,
Where: g the blurred image, h the distortion operator called Point Spread Function (PSF), f the original true image and N Additive noise, introduced during image acquisition that corrupts the image.

1) Point Spread Function (PSF)
Point Spread Function (PSF) is the degree to which an optical system blurs (spreads) a point of light. The PSF is the inverse Fourier transform of Optical Transfer Function (OTF) in the frequency domain ,the OTF describes the response of a linear, position-invariant system to an impulse.OTF is the Fourier transfer of the point (PSF).

III. Deblurring Techniques
This paper applying three methods of deblurring images:

3.1. Wiener Filter-
Wiener filter is a method of restoring an image in the presence of noise and blur [4]. Wiener Filter is a minimum mean square error filter. It has capabilities of handling both the degradation function as well as the noise, unlike the inverse filter. In Global Wiener, a Wiener filter is applied over the whole image. This method does a good job at deblurring; however, it behaves very poorly when the image is corrupted with large noise. The Wiener filter would work well for an image which has similar local statistics throughout the entire image. The advantages of this method are that it is not computationally intensive and that it works well for smooth images (whose local statistics do not vary much from one part of image to another [3].
The frequency-domain expression for the Wiener filter is:
W(s) = H(s)/F+(s), H(s) = Fx,s (s) eas /Fx(s)
Where: F(s) is blurred image, F+(s) causal, Fx(s) anticausal.

3.2. Median filter-

A median filter belongs to the class of nonlinear filters unlike the mean filter. The median filter also follows the moving window principle similar to the mean filter. A 3× 3, 5× 5, or 7× 7 kernel of pixels is scanned over pixel matrix of the entire image. The median of the pixel values in the window is computed, and the centre pixel of the window is replaced with the computed median. Median filtering is done by first sorting all the pixel values from the surrounding neighbourhood into numerical order and then replacing the pixel being considered with the middle pixel value.

123	125	126	130	140
122	124	126	127	135
118	120	150	125	134
119	115	119	123	133
111	116	110	120	130

Neighbourhood values:

115,119,120,123,124,125,126,127,150

Median value: 124

3.3. Curvelet-

The Curvelet transform is a higher dimensional generalization of the Wavelet transform designed to represent images at different scales and different angles.

Curvelets enjoy two unique mathematical properties:-

1) Curved singularities can be well approximated with very few coefficients and in a non –adaptive manner.

2) Curvelets remain coherent waveforms under the action of the wave equation in a smooth medium. Curvelets are a non-adaptive technique for multi-scale object representation. Being an extension of the wavelet concept, they are becoming popular in similar fields, namely in image processing and scientific computing.

Curvelets are appropriate basis for representing images (or other functions) which are smooth apart from singularities along smooth curves, where the curves have bounded curvature, i.e. where objects in the image have a minimum length scale. This property holds for cartoons, geometrical diagrams, and text. As one zooms in on such images, the edges they contain appear increasingly straight. Curvelets take advantage of this property, by defining the higher resolution curvelets to be skinnier the lower resolution curvelets. However, natural images like photographs do not have this property; they have detail at every scale [3].

IV. Methodology

Curvelet transform is a multi-scale local transform essentially. First, we used wavelet transform methods ,which would decompose signal into a series of different sub bands, then using local ridgelet transform for each subband signal. And the size of sub-block in local ridge wave would vary due to scale change. The Curvelet decomposition of function f(x, y) includes the. Shown in Figure (1)

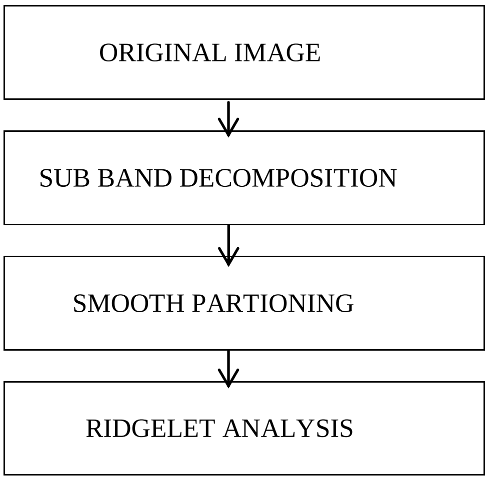

Figure 1: Steps in Curvelet Transform

Steps In Curvelet Transform: The Curvelet decomposition of function f(x, y) includes the following steps:-

1) Sub-Band Decomposition. Through wavelet transform the signal was decomposed into multiple sub-band components or layers.

Each layer contains details of different frequencies:

a) $P0$ – Low-pass filter.

b) Δ 1, Δ2… – Band-pass (high-pass) filters.

The original image can be reconstructed from the sub-bands:

POf is "smooth" (low-pass), and can be efficiently represented using wavelet Base.
The discontinuity curves effect the high-pass layers $\Delta s\ f$.
Can they be represented Can they be represented efficiently?
(i) Looking at a small fragment of the curve, it appears as a relatively straight ridge.
(ii) We will dissect the layer into small partitions.

2) Smooth partitioning. In this step, the high frequency band will be divided into several sub blocks, and different sub band components can be divided into different sub-block size.

3) Ridgelet Decomposition. The Ridgelet transform was used to each sub-block which was from smoothing & segmenting sub-band [3].

V. Conclusion

For the image deblurring, the curvelet transform is more prevailing method than the other methods. Curvelet transform and well known method such as, Median filter and wiener filter have been applied on digital images. In this research, an image deblurring method has been executed which is trouble-free and skilled system build on curvelet uses PSNR and MSE quality metrics to improve the quality of an image. It produces the maximum PSNR for the output image compared to the other filters. However, the output from Curvelet method is much closer to the high quality image and there is no blurring in the output image unlike the other two methods. Curvelets are an appropriate basis for representing images (or other functions) which is smooth apart from singularities along smooth curves, where the curves have bounded curvature, i.e. where objects in the image have a minimum length scale.

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