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Fourier Transform with Noisy Image

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ABSTRACT

The noise is a major problem in computer vision because it affects image quality and impede the illation. In this paper, we suggest method works on instantaneous transformations that are used in the analysis of the signals representing the image and the frequencies they contain, through which the image can be retrieved or the areas containing the noise where the image is transformed within the complex range and then the original image. Result of this paper are 0.9804 in case SSIM measure and 32.9850 in case PSNR measure.

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1. Introduction

Images are not clear for reasons such as defects in taking pictures, atmospheric problems and low-density level while the camera is being displayed. The noise of an image is a major cause of image degradation. Due to blurring, we cannot get exact details of the original image. De-noising is a process to remove the noise from image and restore image with high quality. Noise also corrupts the image so we need to perform de-noising on image [1]. Applications of de-noising include iris recognition [2], image segmentation, information retrieval, astronomy, microscopy, space observation [3], video object extraction, etc. There are many types of noises like a Motion noise, Gaussian noise, Salt & Pepper noise,

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Speckle noise and Poisson noise, etc. The average filter used to remove noise from image and it is useful when noise present and affect the whole image. Gaussian noise is simulated by Gaussian function. Effect of this noise is produced through a Gaussian filter that follow the curve in the shape of a bell. Noise the dense center and indulge on the edge [4], surroundings and outside conditions can affect the image quality during the process of the image acquiring. Image de-noising is based on the degradation model. Noising process can be formulated as the convolution of a clear or the original image with a point -spread-function (filter) of noise.

2. Related Works

The de-noising algorithms create a model for image restoration is similar to process camouflage nucleus with sharp image, which can be called of de-convolution [5]. The kernel represented by the noise is one of the fields that move forward, since the known ballot is that the kernel is space-invariant [5], where it is useful only if the scene results from the vibration of fixed cameras location is the main source of fog generation and even if this hypothesis is completely true, the problem is very difficult and therefore requires coordination and organization, e.g., television [6], distribution of heavy tail gradient [7], Gaussian distribution [8], and for the shape of the kernel, e.g., scatter of the kernel [9] or parametric kernel modeling [10]. We can use neural networks to learn deeply with noise, which are outcomes that are approach to reality [11]. A few ways to relax this assumption by estimating non-uniform noise beads [12]. Many approaches may go further in this direction using optical flow techniques to test noise for each pixel in the image [13]. Areas of strength for these methods include working on a physical model to create images more clearly. On the other hand, the images that are processed manually are not realistic and often produce unclear objects in the target image. There are other methods, methods to solve this problem is through neural networks, and direct learning is a method with distinct results because of the collection of the picture is relevant. The noise kernel cannot be used where it is not determined from the target image, where this paper propose complete learning strategies to estimate the underlying image.

3. Fourier Transform

3.1. Fourier Transform properties

These transformations are one of the most significant tools in the area of image processing and have the ability to analyze the signal (image) to the components of sinusoidal and cosine .Where the results obtained from the Fourier transform of the image to the corresponding numerical values are complex values, the input image is a spatial area, while it becomes after conversion within the frequency. Each pixel in the input image is within the spatial range to a certain frequency in the Fourier transform. These conversions are used in multiple fields and implementation, such as image analysis, image filtering, image rebuilding and image compression. The DFT is one of the models that uses Fourier transform especially in compression images and generally does not contain all the frequencies that make up the image, but only a group of samples, it is sufficient to express the image in the spatial domain in full. The number of duplicates agree to the number of pixels in the image so that the image is equal in size to the spatial area and frequency [14][14]. Equation 1, representation convert from time domain into frequency domain. Figure 1, shows Fourier transform.

$$F(K,L) = \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} f(i,j) e^{-i2\pi\left(\frac{Ki}{N}+\frac{Lj}{M}\right)} \quad (1)$$

Where $f\ (i,j)$the image in time domain and Fourier space is$F(\ K\ ,L)$ is image in frequency domain. The equation can be explained as where the average of each pixel is found in the frequency by multiplying the image with a spatial area with base function and summing the outcome.

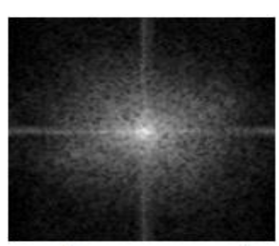

Fig. 1: Fourier Transform

Inverse Fourier transform is given by equation 2 as follows:

$$f(i,j) = \frac{1}{M} \sum_{k=0}^{N-1} \sum_{l=0}^{M-1} F(K,L) e^{i2\pi\left(\frac{Ki}{N}+\frac{Lj}{M}\right)} \quad (2)$$

Where $\frac{1}{M}$ Normalization term in the inverse transformation. Figure 2 shows apply Fourier transform on images.

There are several properties characterized by Fourier transform [15]:

1. Linearity: Includes all complex number c,d if

$$h(x) = cf\,1(y) + dg1(y), thereafter\ \ \hat{h}(\xi) = c \cdot f(\xi) + d \cdot \hat{g}(\xi). \quad (3)$$

2 -Translation / time shifting: Includes all real numbersy_1 if

$$h(y) = f(y - y1), then\ \hat{h}(\xi) = e - 2\pi ix0\xi\ f(\xi). \quad (4)$$

3-Modulation / frequency shifting: Includes all real numbers ξ0, if

$$h(y) = e2\pi ix\xi 0\ f(y), then\ \hat{h}(\xi) = f(\xi - \xi 0). \quad (5)$$

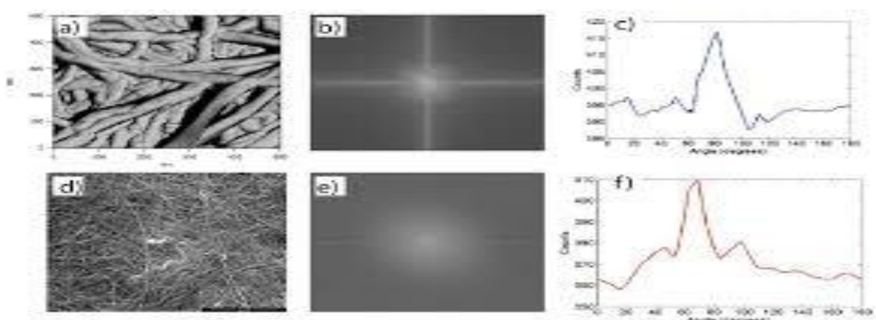

Fig. 2: Fourier Transform Apply Images

3.2 Types Filters for Fourier Transform

1- High pass filter: is a filter that works to reject or reduce low frequency and high frequency transitions.

2- Low pass filter: is a filter that passes low-frequency signals and reduces the frequency of signals with higher frequencies than the shut-off frequency.

4. Proposed Method

In this section discuss steps of proposed method, where algorithm 1 explain this step to get de-blurring of images.

Algorithm 1: Restoration Image noising

Input: noising image.

Output: De-noising image.

1. Converts class of input image into double class.
2. Created disk filter of size 4*4.
3. Compute Fourier transform of disk filter by equation (1) to give filter (g) size equal size of the input image.
4. Convert input image into frequency domain$F(i,j)$.
5. Compute follows equation:$W = F(i,j)/g$.
6. Compute follows equation:$R = W(i,j) * g$.
7. Compute inverse of Fourier transform of the image R.
8. Tack real numbers from of the step7 results.
9. Apply some measure on image to find similarity and noise ratio such that (SSIM, PSNR, and MSE).

Result is de-noising image.

We will explain the steps mentioned in the algorithm above:

Step1: The input image of any type is converted to a double whose values are between zero and one for easy handling with Fourier, which generates complex values.

Step2: A filter of a disk type is created, which is one of the filters that add noising to images and whose values are in spatial range.

Step3: Since the image processed by the Fourier transform must be the filter added within the frequency so that the filter disk to the frequency range using Fourier.

Step4: Convert input image into Fourier transform.

Step5: Divided the image (F) on filter (g) then the result (w) multiplies by filter (g).

Step6: At this stage is used inverse Fourier transform in order to eliminate the noise from the image, and restore features where there are no remains of the artifact.

Figure 3 shows result of proposed method. Table (1) explain some measure used in proposed method.

4. Discussion Results

The proposed algorithm implemented with many gray scale image and color image to test the algorithm performance, the performance measured by using PSNR and visual effect:

1. Mean Square Error (MSE): Its impersonation the quality of deblurring image. Its equation:

$$MSE = \sum_{i=1}^{N}\sum_{j=1}^{M}(C(i,j) - I(i,j))^2/M * N \quad (6)$$

Where C is de-blurring image, I is input image, and N and M is the image size.

2. Peak Signal-to-Noise Ratio (PSNR): It's the ratio of the maximum signal to noise in the blure image. PSNR value if large indicates the better quality of the image and lead to less distortion. Its equation:

$$PSNR = 10\, log10\, (MAX^2/\, MSE) \quad (7)$$

Where MAX is high gray level of image, $MAX = 255$.

3. Structural Similarity Index (SSIM) for measuring image quality: The indicator is based on three terms: the luminance, the variance criterion, and the structural term.

$$SSIM(A,B) = \frac{(2\mu_A\mu_B + C_1)(2\sigma_{AB} + C_2)}{(\mu_A^2 + \mu_B^2 + C_1)(\sigma_A^2 + \sigma_B^2 + C_2)} \quad (8)$$

Where

$$\mu_A = \frac{1}{M}\sum_{i=1}^{M} A_i\, , \mu_B = \frac{1}{M}\sum_{i=1}^{M} B_i\, , \quad (9)$$

μ_A is average of the vector A ,A_i is values of the vector A where i from 1 to M, μ_B is average of the vector B, $C_1 = (K_1L)^2$, while L is the largest number in pixels values (255 for 8-bit grayscale images), and finally K_1 is equal one or less than one.

$$\sigma_A = \sqrt{\frac{1}{M}\sum_{i=1}^{M}(A_i - \mu_A)^2} \quad , \sigma_B = \sqrt{\frac{1}{M}\sum_{i=1}^{M}(B_i - \mu_B)^2} \quad (10)$$

σ_A is standard deviation of the vector A,A_i is values of the vector A where i from 1 to M and μ_A is average of the vector A, σ_B refers to standard deviation of the vector B, the variance of the vector A is σ_A^2, the variance of the vector B is σ_B^2,$C_2 = (K_2L)^2$, K_2 is equal one or less than one. Standard deviation of the two images is computed as follows:

$$\sigma_{AB} = \frac{1}{M-1}\sum_{i=1}^{M}(A_i - \mu_A)(B_i - \mu_B) \quad (11)$$

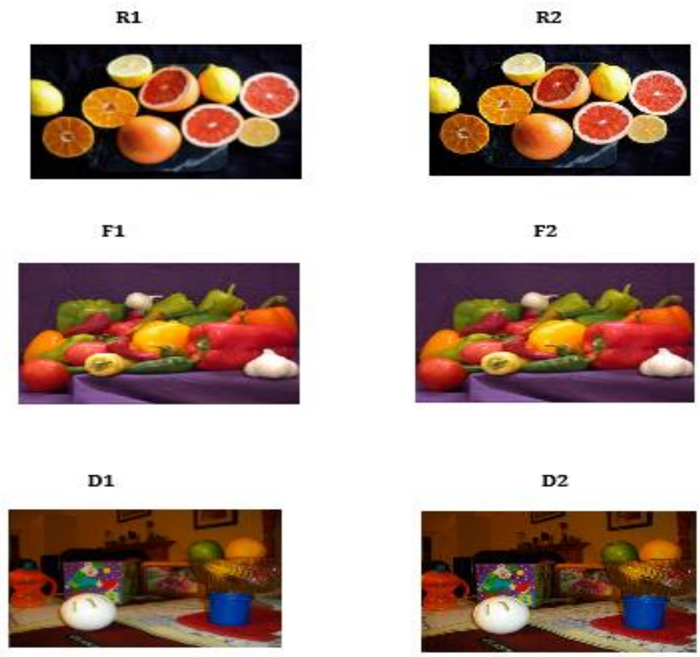

Fig. 3: The result of proposed method, where R1, F1, and D1 represent noisy image, and R2, F2, and D2 is de-noise image.

Table (1) proposed measures method.

Images / Measures	R1,R2	F1,F2	D1,D2
PSNR	28.7654	32.9850	31.1361
SSIM	0.9250	0.9804	0.9582
MSE	0.0004	0.0001	0.0002

6. Conclusion and Future Work

In this paper we suggest a simplified method for removal the noise of the image and restore its features clearly through the use of Fourier transform to remove the distortion of the image and save information and remove scars on them, the performance measured by using PSNR and visual effect MSE and SSIM criteria were good results and do not need to improve using filters optimization.

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