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Image Enhancement

By Using Homomorphic Filtering Model

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ABSTRACT

A number of techniques have been proposed in the literature to deal with the illumination induced appearance variations ranging from simple image enhancement techniques, such as histogram equalization or gamma intensity correction. In this paper we proposed a homomorphic filtering model or the logarithmic total variation model to enhance non uniform illumination in real experimental image**.** This model will be enhancing the brightness in high frequency and in low frequency. We improved the image by using the output resulted from our proposed model as input again to this model, the final enhanced image is de-noised from all unwanted details and the edge will be enhanced in all direction. Some fidelity parameters is applied and we obtain an acceptable results.

1. INTRODUCTION

I Image enhancement is used when the image has a degradation of natural look and the contrast is higher. The contrast enhancement is a widely using image enhancement technique. The difference between contrast of color image and the brightness makes an object in the scene distinguishable. The brightness is the feature of vision that defines how much light the source reflects makes the source appears to be reflecting the light. But the brightness and the lightness are two different aspects [1]. The contrast can also be defined as the amount of color or the grey scale differentiation value that exists between various images. Many algorithms, such as the Retinex based algorithms [2], the unsharp masking algorithms [3], and the histogram equalization (HE) algorithms [4], etc., are proposed to enhance the image brightness. These algorithms are focused on detail enhancement, but the result of these algorithms is given unnatural looks, caused by light source confusion and artifacts. Therefore others attempt to reduce over-enhancement at the cost of the details [5]. A strong correlation with reflectance and the amount of visible light reaching observers depends on the product of reflectance and illumination assumed in

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Retinex theory [6]. In fact, the reflectance value range is [0, 1], which means the surface cannot reflect more light than that it receives. Moreover, it is unreasonable to simply remove the illumination which is essential to represent the ambience [7]. The bright-pass filter which is used to preserve the natural look in the non-illumination images also restricts the reflectance to 0 and 1. This will give the output as grey scale image. But the complexity of implementing the bright-pass filter is more compared with the other enhancement algorithms [6].

The intensity is needed to preserve in an enhancement applications. Therefore, for non-uniform illumination images, brightness preservation is disadvantageous to detail enhancement in the areas of inappropriate intensity, such as the dark areas [8].

2. PROPOSED IMAGE ENHANCEMENT MODEL

In this paper an enhancement model is proposed to enhance an image that collected from real experimental of LASER generation. This model will be applied on these images in frequency domain by using homomorphic filter. This model is depend on the image has produced high energy that received from object. The energy received is determined by illumination radiation source and the features of reflectance of the object itself. The relationship is viewed as product between two components of energy (i.e., illumination and reflectance components) to produce an optical image [9] [10]:

$$f(x,y) = i(x,y)r(x,y) \dots.(1)$$

Where: f(x,y) is an optical image, and i(x,y)&r(x,y) are the illumination and reflectance components.

As previously said the reflectance component is means the features of the object itself. Therefore we more interest with reflectance than illumination component. Eq.1can is converted into linear model by using the log operation such as:

$$logf(x,y) = logi(x,y) + logr(x,y) \dots.(2)$$

Form Eq,2 can be easy to process in frequency domain, because the illumination component lies in low frequency band and reflectance in high frequency band. Discrete Fourier transform (DFT) is applied on eq.2, and then high pass filter is used to enhance reflectance part and degrade the other. After enhancing done the inverse DFT (IDFT) is used to reconstruct the original image after exponential operation is used to convert the illumination-reflectance original space. All these process called Homomorphic filter is shown in Fig.1.

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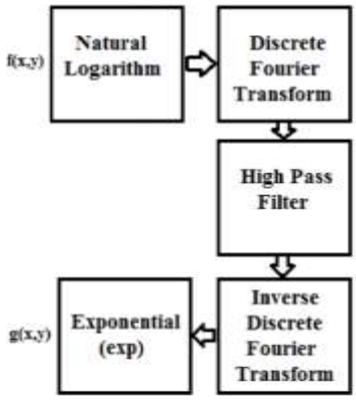


FIGURE 1: Homomorphic filter steps

Pearson Correlation Coefficient factor can be calculated from eq.3

$$PCC = \frac{\sum signal1 \times signal2}{std(signal1) \times std(signal2)} \ldots . (3)$$

3. RESULTS AND DISCUSSION

In the real world the corrupted images are expected to be the way the image that is corrupted by this type of non-uniform illumination. The corrupted image under investigation is as shown in Fig.2. Also Fig.2 showed the original color image and the converted gray scale image. The aim of the paper is to use homomorphic filter out the illumination component to enhance the original image.

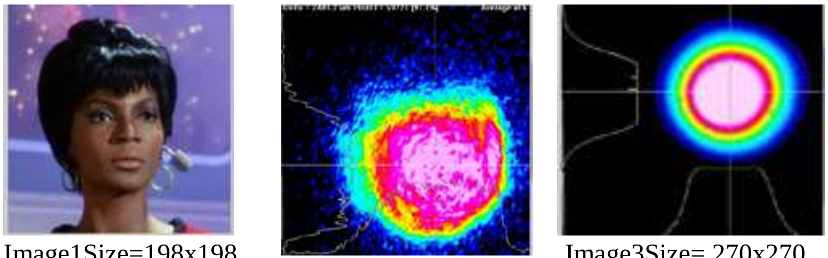
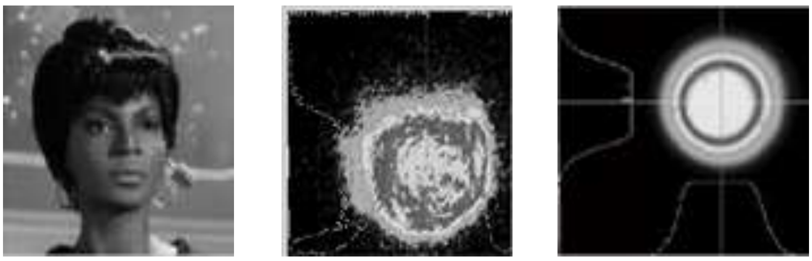


Image1Size=198x198 Image2Size 383x383 Image3Size= 270x270

(a)



(b)

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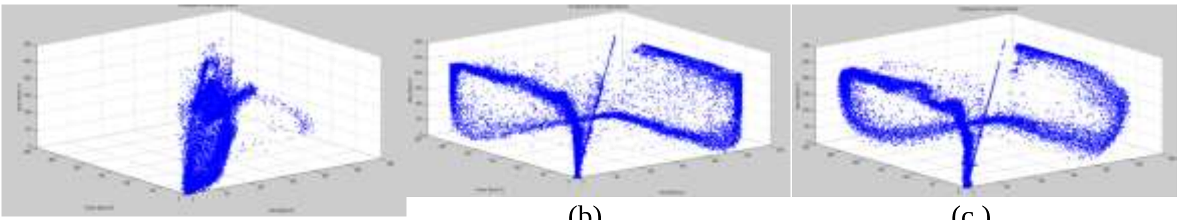
FIGURE 2: original non-uniform illumination image, a) color image and b) gray scale image

Fig.3 illustrated the brightness distribution by drawing histogram in 3-D of the original images.

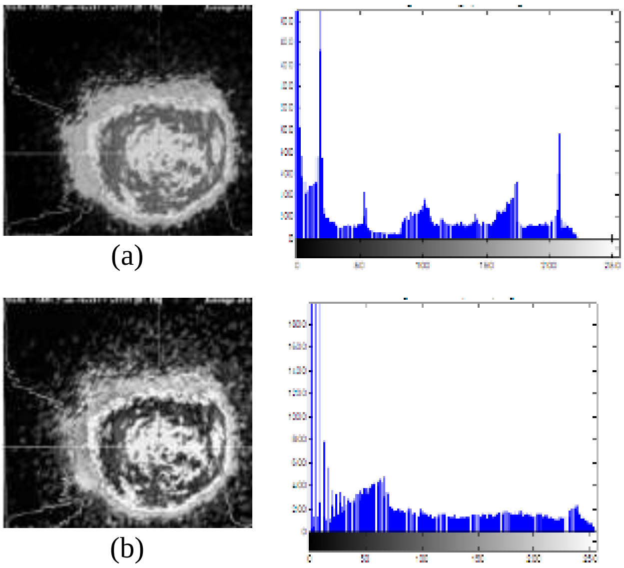


(a) (b) (c)

FIGURE 3: 3-D histogram of original images: a) image1, b) image2, and c) image3.

Before enhancement model applied we modify the brightness by using equalization histogram, Fig.4 is illustrated the gray scale image modification with its histogram.

Brightness modification insufficient which is shown in Fig.4, therefore we used another modification to enhance the non-uniform illumination. Homomorphic filtering is used in frequency domain to enhance the brightness more than histogram equalization that applied in spatial domain. Also, homomorphic filtering applied twice time on the resultant image to get more enhance on the brightness without loss any information.



(a)

(b)

PSNR=10.72dB and SNR = 2.51dB

FIGURE.4: Image2 enhancement by using equalization histogram: a) image2 and its histogram before enhancing the brightness, and b) image2 and its histogram after enhancing the brightness

The experimental result is demonstrated in Fig.5. RMSE value is 65.57, MSE= 4299.6, PSNR = 11.83dB, Pearson Correlation Coefficient between original image and enhance

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image (PCC1) value is 38320.85 and Pearson Correlation Coefficient between original image and original image (PCC2) value is 39203.

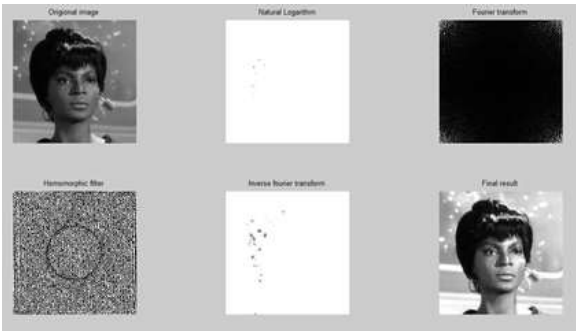

FIGURE 5: Homomorphic filtering applied on Image1and the reconstructed image.

Fig.6 is shown the modification of the brightness distribution by using homomorphic filtering model.

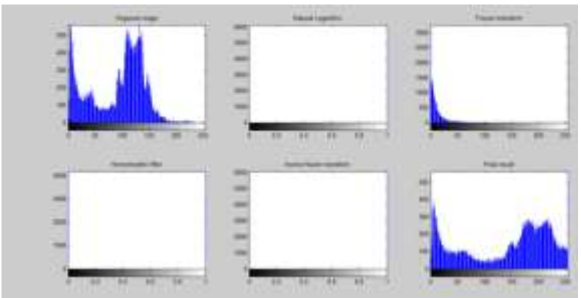

FIGURE 6: Histogram modification by using homomorphic filtering model.

If we use the output image of Fig.5 as input to the enhancement model, therefore we obtain the more enhance image as shown in Fig.7. RMSE value is 45.998, PCC1 value is 37897.38 and PCC2 value is 39203.

(a) (b)

FIGURE 7: Modify homomorphic filtering: a) first applied enhancement, and b) second enhancement.

Figs.8, 9, &10 are shown the real enhancement by using homomorphic filtering model. In Fig.8 the results values are: RMSE = 59.302, MSE = 6154.83, PSNR = 9.77dB, PCC1=127335.17 and PCC2=146688. Fig.9 demonstrated the histogram of each steps in homomorphic filtering model. Fig.10 is illustrating the output of Fig.8 used as input of Fig.10 and the values of image fidelity are: RMSE= 69.509, PCC1= 139365.96 and PCC2= 146688.

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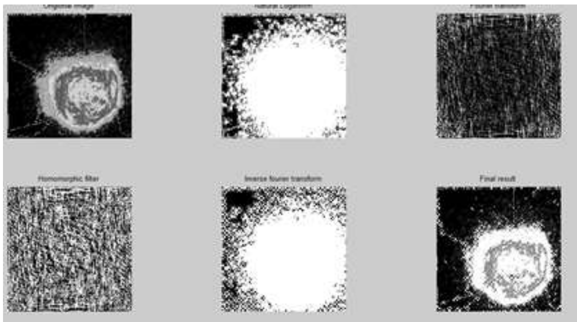


FIGURE 8: Homomorphic filtering applied on Image2, and the reconstructed image.

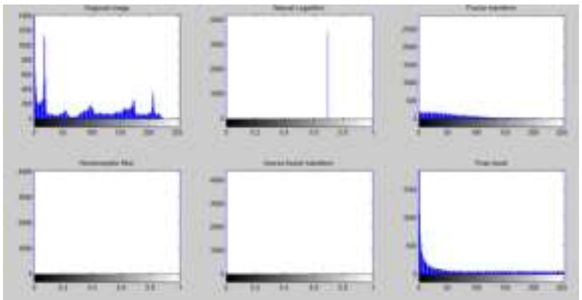
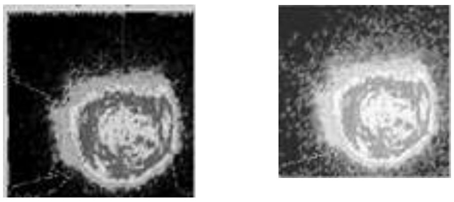


FIGURE 9: Histogram modification of each steps of homomorphic filtering model.



(a) (b)

FIGURE 10: Modify homomorphic filtering: a) first applied enhancement, and b) second enhancement

Figs.11, 12, &13 are shown the real image3 enhancement by using homomorphic filtering model. In Fig.11 the results values are: RMSE = 42.60, MSE = 1717.61, PSNR = 15.35dB, PCC1= 66184.02, PCC2=72899.

Fig.12 showing the histogram graph of each steps of homomorphic filtering model. Fig.13 is illustrating the output of Fig.8 used as input of Fig.9 and the values of image fidelity are: RMSE = 132.59, PCC1= 70035.66, PCC2= 72899.

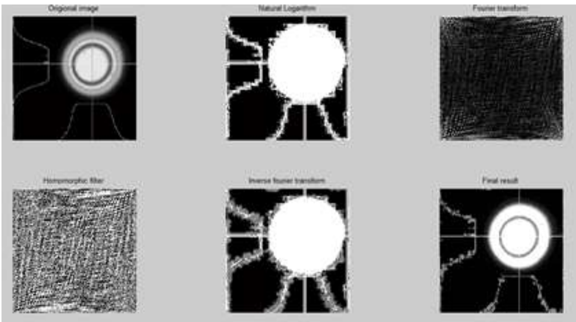


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FIGURE 11: Homomorphic filtering applied on Image3, and the reconstructed image.

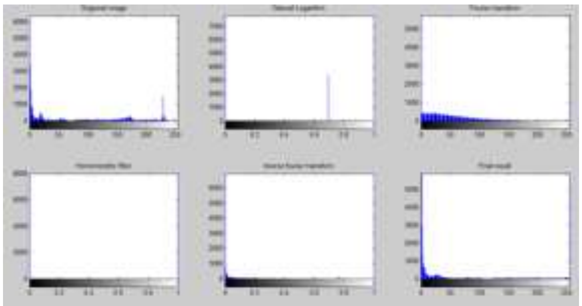
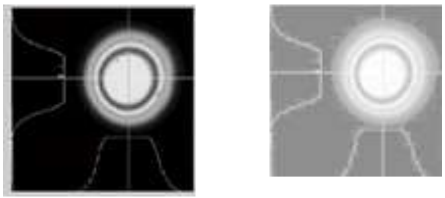


FIGURE 12: Histogram modification of each steps of homomorphic filtering model.



(a) (b)

FIGURE 13: Modify homomorphic filtering: a) first applied enhancement, and b) second enhancement

4. CONCLUSIONS

The proposed modification model is enhanced the illuminate component of the non-uniform brightness images that collected from the output LASER experiment. The brightness is modified the brightness in high frequency and in low frequency therefore, we improved the results by using homomorphic filtering two times and we get acceptable results of some fidelity parameters.

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