Microscopic Image Denoising And Sharpening Techniques

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Abstract

Microscopic images like some microorganism images contain different type of noises which reduce the quality of the images. Removing noise is a difficult task. Noise removal is an issue of image processing. Images containing noise degrade the quality of the images. Different types of noise should be known to improve the quality of microscopic image.

*Keywords—***Salt & Pepper Noise; Wavelets; PSNR; MSE**

I. INTRODUCTION

In this paper, a review of different methods of sharpening of noisy image is presented. The proposed method includes two steps: suppressing the noise step and sharpening step. Medicine and biotechnology are very popular area where images of microorganism are used. To diagnose some disease which is related to fungus, analysis of microorganism is required. To identify different types of microorganism, qualitative analysis is required [1].It is very difficult to do analysis of microscopic images because of the noise which comes due system noise, motion of the object and condition of the environment [2]. There are number of algorithms for noise removal.

II. NOISE SOURCES IN MICROSCOPY AND MICROSCOPIC IMAGES

In method of microscopy there are two general types of noise: intrinsic or statistical noise and measurement noise. Measurement noise can have both random and patterned components. In fact, the statistical noise associated with the patterned noise signal cannot be removed entirely and; in addition, the process of trying to remove the patterned noise may itself introduce additional random noise. Finally, there is noise associated with the signal detected from other than the plane of focus. This is referred to as "image noise" [3].The primary undesirable signal components (noise), which degrade the performance of a CCD imaging device by lowering signal-to-noise ratio are;

A. PHOTON NOISE

This is also called as shot noise that occurs from the variation of the photons which are falling on the CCD. Photoelectrons generated in the semiconductor device constitute the signal, the magnitude of which is disturbed by fluctuations that follow the Poisson statistical distribution of photons incident on the CCD at a given location. That's why the photon noise or measurement variation is equal to the square-root of the signal [4].

B. DARK NOISE

Dark noise comes from statistical variation in the number of electrons thermally generated in the silicon structure of the CCD, which is highly dependent on device temperature but independent of photon-induced signal. Dark current is the rate of generation of thermal electrons at a particular CCD temperature. The dark current reduces quickly by cooling the CCD [5].The electronic noise due to the thermal motion of electrons in resistive circuits is called as white Gaussian noise with zero mean value.

C. READ NOISE

This is a combination of two type of noise; first the system noise components which arises in the process of converting CCD charge carriers into a voltage signal and second is analog-to-digital conversion. Photo electronic noise is due statistical nature of light and of the photo electronic conversion process that takes place in image sensor. At low light levels, photo electronic noise is often modeled as random with a Poisson density function. At high levels, the Poisson distribution approaches the Gaussian.

Images originally recorded on photographic film are degraded by noise called film grain noise, also called as Gaussian white noise. The electronically recorded images from different types of microscope are affected by all these types of noise. Image noise is generally regarded as unwanted product of image capture. Image noise can be taken as differently on the basis of different criterion. The criterion includes the cause of image noise generation, the shape of the noise amplitude distribution over time, noise spectrum and the relationship between noise and signal and so on. The types of noise can be Gaussian Noise, Impulse Noise, Speckle Noise, and Additive Noise. Gaussian noise is the type of noise in which, at each pixel position (i, j), the random noise value, that effects the true pixel value is drawn from a Gaussian probability density function with mean μ (i, j) and standard deviation σ (i, j) [6]. The probability density function of a Gaussian random variable, z, is given by

$$P(z) = (1/\sigma\sqrt{2\prod})e^{-(z-\mu)^2/2\sigma^2} \quad (1)$$

Where z represents gray level.

Impulse noise changes value of some pixels at random. This is also called Salt and Pepper noise. The PDF of Salt and Pepper noise is given by

$$p(z)\begin{cases} = & p_a & z = a \\ & p_b & z = b \\ & 0 & otherwise \end{cases} \quad (2)$$

If b > a gray level b will appear as a light dot in the image. Conversely, level a will appear like a dark dot.

III. NOISE SUPPRESSING METHODS

Different methods of denoising based on noise characteristics can be selected. Noise can be suppressed in both space domain and frequency domain.

A. FREQUENCY DOMAIN FILTER

Frequency refers to the rate of repetition of some periodic event. In image processing, spatial frequency refers to the variation of image brightness with its position in space. A varying signal can be transformed in to a series of periodic variations. The Fourier transform decomposes a signal in to a set of sine waves of different characteristics like frequency and phase. If we compute the Fourier transform of an image, and then immediately inverse transform the result, we can regain the same image because a Fourier transform is reversible. On the other side, if we multiply each element of the Fourier coefficient by a suitably chosen weighting function then we can attenuate certain frequency components. The corresponding changes in the spatial form can be seen after an inverse transform is computed. The selective enhancement or suppression of frequency components is termed frequency domain filtering. In frequency domain filtering, the image data is dissected in to various spectral bands, where each band depicts a specific range of details within the image. The process of including and excluding frequency is called as frequency domain filtering [7].

Gaussian filter is a linear filter and in two dimension is given by

$$H(u,v) = \exp(-D^2(u,v)/2\sigma^2) \quad (3)$$

B. SPATIAL DOMAIN FILTER

Median Filter as a non-linear operation is a spatial method of reducing Salt and Pepper noise in an image. The operations of Median filter on an image removes noise from an image with minimum blurring of the image. The median of all pixels within the local region of an image is called as Median filter. Pixels which all are included in the median calculation are defined by a mask. The Median filter can easily remove outlier noise from images that contains less than 50 percent of its pixels as outliers. Median filter replaces the value of a pixel by the median of the intensity level in the neighbourhood of that pixel [8].

Such noise reduction is pre-processing step to improve the result of later processing. The main idea of the median filter is to run through the signal entry by entry, replacing each data with the median of the neighbourhood. Median filter

$$\mathrm{Median(A)} = \mathrm{Median[A(x+i, y+j)]} \quad (4)$$

Where the coordinate x+i, y+j is defined over the image A and the coordinate (i, j) is defined over the mask M. The mask M determines which pixels are to be included in the median calculation.

IV. IMAGE SHARPENING

Sharpening is the process of manipulating an image so that image is more suitable than the original image. In general if single image enhancement method will be implemented, actual requirements will be obtained. To get better visual effect for images, researcher performs filtering of image first and then sharpens the image. Image enhancement can be divided in two domains.

A. SPATIAL DOMAIN IMAGE SHARPENING

Spatial domain image enhancement includes: gray level transformation, histogram, processing, basic spatial filters and unsharp masking. The process of unsharp masking is the technique used for enhancement. In this approach, a smooth version of the image is subtracted from the original image, hence, getting the image balance towards the sharper content of the image [9].

Mathematically, the Unsharp masking operation is given by

$$f'(m,n) = f(m,n) + \alpha\left[f(m,n) - \overline{f}(m,n)\right] \quad (5)$$

Where $f(m,n)$ is the original image.

$\overline{f}(m,n)$ is the blurred version of the original image.

α is the weighting fraction.

$f'(m,n)$ is the sharpened result.

Here linear unsharp filter is used to enhance the noisy image. With this, visual effect will increase.

B. IMAGE SHARPENING IN FREQUENCY DOMAIN

There are number of methods for image enhancement in frequency domain i.e. sharpening frequency domain filters, smoothing frequency domain filter and Homomorphic filtering.

A Homomorphic filter combines aspects of two or more domain such as non-linear mapping function and spatial frequency filter. An image model where high spatial frequency are associated with reflective components of the picture and low frequency variations are associated with illumination components, then a spatial frequency filter that operates on these elements independently can effect huge changes in either components. In image, problem exists because illumination and reflective components are multiplicative.

The basic model is given by:

$$\mathrm{F(x, y) = I(x, y)R(x, y)} \quad (6)$$

Where F(x,y) is the image, I(x,y) is the image illumination component and R(x,y) is the reflectance. Log of the picture will allow independent processing of the components [10].

$$\mathrm{Log(F(x, y)) = log(I(x, y)) + log(R(x, y))} \quad (7)$$

If we take the Fourier transform of the log image and apply filter on the image, a low pass filter will have more effect on illumination and high pass on reflectance. This is effective because of the spatial relationship of the log and Fourier transform to the scene components in the picture [11,12].The image is little blurry and many of its low intensity features will be obscured.

V. CONCLUSION

In this paper, different techniques are used to remove noise from the microscopic image. Based on the behaviour of types of noise ,different techniques can be appliedto removemicroscopic image noise. But for microscopic images, if noise removal techniques is combined with sharpening techniques then result of image quality will be much better. This paper concludes that there are numerous techniques for image de-noising and sharpening that are applied.
As there are number of image de-noising techniques used but still there is lot to happen. Further studies can be done in this field to provide more effective methodologies.

VI. REFERENCES

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