Effect of Poisson Noise on Remote Sensing Images and Noise Removal using Filters

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ABSTRACT

This paper addresses the issues of noise which involve pre-processing task before using images for various applications. We have applied various filters on remote sensing images for denoising them. The fundamental key challenge to noise reduction is to reduce or eliminate the noise without failing other aspects of the image. Image denoising involves the manipulation of the image data to produce a visually high quality image. There are many kinds of noise has affect remote sensing images but we have selected only Poisson noise and interpret the results thus, we took remote sensing images that denoising them with a Average filter, Median filter, Unsharp filter and Wiener Filter and used statistical quality measured in this work.

Key words: Filter, image, Poisson noise, Remote Sensing Images

Introduction

An image is a picture, photograph or any other form of 2D representation of any scene[1].Most algorithms for converting image sensor data to an image, whether in-camera or on a computer, involve some form of noise reduction. There are many procedures for this, but all attempt to determine whether the actual differences in pixel values constitute noise or real photographic detail, and average out the former while attempting to preserve the latter. However, no algorithm can make this judgment perfectly, so there is often a tradeoff made between noise removal and preservation of fine, low-contrast detail that may have characteristics similar to noise. Many cameras have settings to control the aggressiveness of the in-camera noise reduction.

Remote Sensing Image

In remote sensing energy emanating from the earth's surface is measured using a sensor mounted on an aircraft or spacecraft platform. We generally talk about the imagery recorded as image data since it is a primary data source from which we wish to extract usable information. Possibly the most significant characteristic of the image data in a remote sensing system is the wavelength, or range of wavelengths, used in the image acquisition process. If reflected solar radiation is measured images can, in principle, be recorded in the ultraviolet, visible and near-to-middle infrared range of wavelengths. Because of significant atmospheric absorption, ultraviolet measurements are not made. Most common, so-called *optical*, remote sensing systems record data from the visible through to the near and mid infrared range. The energy emitted by the earth itself(dominant in the so-called *thermal* infrared wavelength range) can also be resolved into different wavelengths that help us understand the properties of the earth surface region being imaged [3]. So RS Image data or Image taken from Sources is costly due to that we took pan

Figure 1:Original image: Concordorthophoto RS Image [20-21].

Image Noise

Image noise represents unwanted information which degrades the image quality to enhance the quality we use filtering. Noise is defined as process (n) which adds with original image(s) and affects the acquired image (o) as shown equation (1).

$$o(i,j)=s(i,j)+n(i,j)\ldots\ldots..(1)$$

Figure 2: Poisson noise added image.

Poisson Noise

Poisson noise or shot noise is a type of electronic noise that occurs when the finite number of particles that carry energy, such as electrons in an electronic circuit or photons in an optical device, is small enough to give rise to detectable statistical fluctuations in a measurement [11].

This type of noise is caused by the nonlinear response of the image detectors and recorders. Here the image data dependent (signal dependent) term arises because detection and recording processes involve random electron emission having a Poisson distribution with a mean response value (Timmermann and Novak, 1999). Since the mean and variance of a Poisson distribution are equal, the signal dependent term has a standard deviation if it is assumed that the noise has a unity variance. This noise affects the natural images (Zhang, Fadili and Starck, 2007; Yunyi and Baolong, 2006). The number of observed occurrences fluctuates about its mean, μ, with a standard deviation, σ. These fluctuations are denoted as Poisson noise or as shot noise. Poisson noise follows a Poisson distribution (Gonzalez and Woods, 1992). The Poisson probability distribution function is given by Equation (3). μ= mean value and x= gray level [6].

$$P(x) = \frac{\mu^x e^{-\mu}}{x!}; \quad x > 0 \quad \text{........(2)}$$

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Poisson noise is also known as shot noise. It is a type of electronic noise. Poisson noise occur under the situations where there is a statistical fluctuations in the measurement caused either dueto finite number of particles like electron in an electronic circuit that carry energy, or by thephotons in an optical device [7].

An important task in mathematical image processing is image denoising. Many image Denoising algorithms assume that the noise is normally distributed and additive. Many images, however, contain noise that satisfies a Poisson distribution. The magnitude of Poisson noise varies across the image, as it depends on the image intensity which removes Poisson noise while preserving image features that other methods remove [10].

Experimental Analysis

In this experimental work, we are using the different filtering techniques into single one passion noise and denoising remote sensing image. There are three different noise sources as possible noises but Poisson noise will be added to original image here we want to improve the quality of image and to measure the quality of image. Then, we discuss experiments with Average Filter, Median Filter, UnSharp Filter and Wiener Filter and comparative result with RS images.

The performance is quantified by the peak signal-to-noise ratio (PSNR)

$$PSNR = 10\log_{10}\frac{|x|^2_{\max}}{MSE} \quad \ldots\ldots. (3)$$

is the maximum value admitted by the data format equation (3) and (4) the mean-square error (MSE)

$$MSE = \left\langle [x(n) - \hat{x}(n)]^2 \right\rangle \quad \ldots\ldots.. (4)$$

is computed as a spatial average ·, with x and ˆx being the original and denoised images, respectively. In the TABLE I who gives comparative results of original, add Noise, with filter Average P_1, Median P_2, UnSharp P_3 and Wiener P_4. (P for Poisson Noise and filter name respectively).

As far as Piosson noise is concerned the performance of Average Filter is good by MSE, and on the other hand Median Filter is good by PSNR. The result has shown in TABLE I.

While looking on histogram of Gaussian noise and Salt & Pepper Noise which have showing all information in gray level intensity varies with different filters.. See at Histogram Fig-3.

A. OriginalImage

B. Poisson Noise

C. Average Filter

D. Median Filter

E. Unsharp Filter

F. Wiener Filter

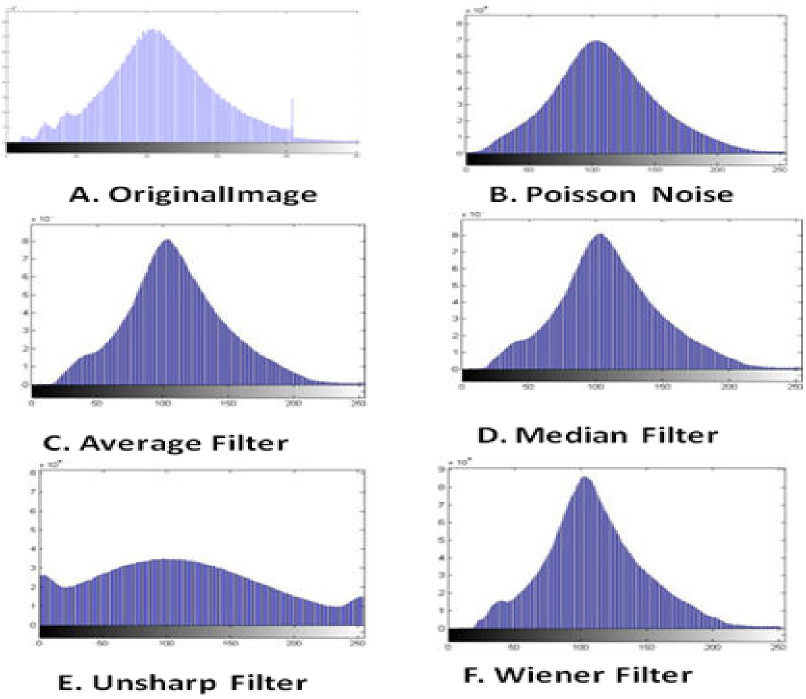
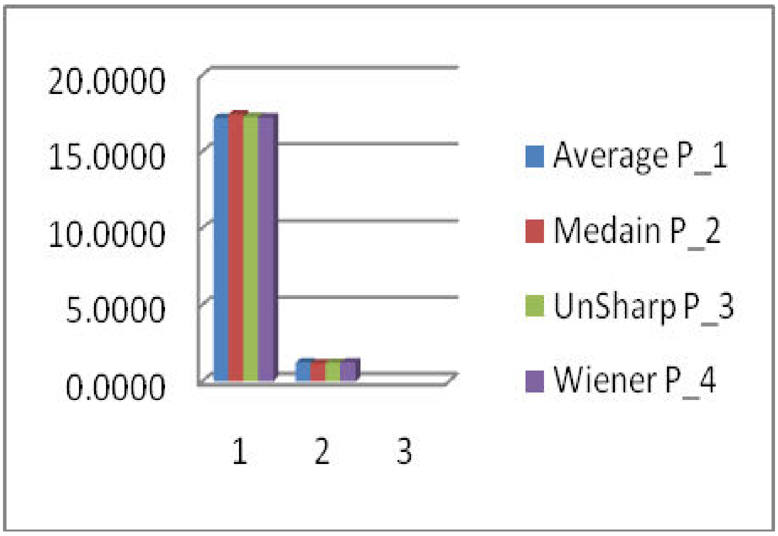


Figure 3: Denoising Using Different Filters and Its Histogram

Table 1: PSNR and MSE Reselust for Poisson Noise Images with Filters

Images	PSNR	MSE
Original	17.3730	1.1906
Add Noise	17.4171	1.1786
Average P_1	17.2411	**1.2274**
Medain P_2	**17.4571**	1.1678
UnSharp P_3	17.2859	1.2148
Wiener P_4	17.2487	1.2252

Graph 1 has shown the denoising results of Poisson Noise among various Filters.



Graph 1: The variation among filters for denoising RS Imges

Conclusion

In this paper, we have studied only Poisson Noise applied four filters on noise affected remote sensing images which have denoised successfully and quality has measured using quality controls. Throughout this experimentation we observed that the performance of Average Filter is good by MSE, and on the other hand Median Filter is good by PSNR. The future scope of this work will be sought to handle different noises in the RS image at minimum time. Another sore point is lack of objective quality measure for Remote sensing images which weaken maximum experimental analysis. Therefore, the effectiveness of all technique for pre-processing increases as the random noise decreases.

Future Work

Filtering methods along with detection algorithms shows better results and once the filtering schemes are done in wavelet domain then efficient results will be found.

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