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Analysis of Effect of Gaussian, Salt and Pepper Noise Removal from Noisy Remote Sensing Images

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Abstract. This paper attempts the pre-processing task of digital images are prone to a variety of noise. Noise is the result of errors in the image acquisition process that result in pixel values that do reflect the true intensities of the real scene due to that the process of removing noise from the original image is still a demanding problem for researchers. The prime focus of this paper is related to the preprocessing of a Remote sensing image before it can be used in applications. In order to achieve these de-noising of noisy remote sensing images. So, therefore we have used the filtering approach and analyze performance of each filter with respect to noise type. At last we have checked the image quality using standard quality measures. Hence, the filtering approach has been proved to be the best filter when the noisy remote sensing image is corrupted with Gaussian, Slat & Paper noises.

Keywords: Remote sensing image, Gaussian noise, Salt and pepper noise, filter.

1. Introduction

Remote Sensing Images are useful in many environmental applications such as tracking of earth resources, geographical mapping, prediction of agricultural crops, urban growth, weather, flood, fire control etc.

Reducing noise from the satellite image is a challenge for the researchers in digital image processing [1–4]. Generally noise is found in synthetic aperture radar images, satellite images and medical images etc [3]. To give considerations and suggestions that is relevant for the development of methods for the detection and reduction. For creating a link to field direct importance to the image analysis community [4]. In this study we have took five remote sensing images. All original names with reference numbers of RS images used in an experiment, (11,12,13,14 and 15 reference no. of with Original RS images names) as shown in below figure 1.

2. Sources of Noise in RS Images

Remote Sensing Images are prone to a variety of types of noise [1,2,4,5]. Noise is the result of errors in an image acquisition process that result in pixel values that do not reflect the true intensities of the real scene [4]. Electronic transmission of image data can introduce noise [5].

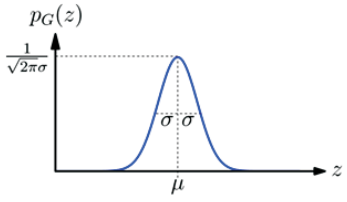

Figure 1. Gaussian probability density function $pG(z)$.

3. Gaussian, Salt and Pepper Noise

Principle sources of Gaussian, Salt & Pepper noise in remote sensing images arise during acquisition e.g. Sensor noise caused by poor illumination and/or high temperature, and/or transmission eg. electronic circuit noise [1].

Gaussian noise is a noise that has its PDF equal to that of the normal distribution, which is also known as the Gaussian distribution. Gaussian noise is most commonly known as additive white Gaussian noise. Gaussian noise is

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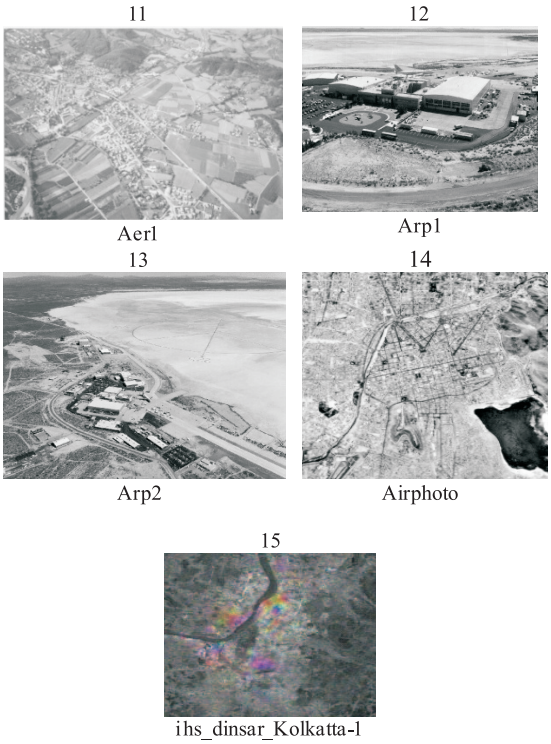


Figure 2. 11,12,13,14 and 15 reference no. of with original RS image names.

properly defined as the noise with a Gaussian amplitude distribution. As the name indicates, this type of noise has a Gaussian distribution expressed in below equation (1) [4].

$$F(g) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-(g-m)^2/2\sigma^2} \tag{1}$$

where g represents the gray level, m is the mean or average of the function and σ is the standard deviation of the noise in equation (1).

The PDF (Probability density function) of a Gaussian random variable Z is given by where Z represents the grey level, μ the mean value and σ the standard deviation see the equation (2) and figure 1 [6,7].

$$pG(z) = \frac{1}{\sqrt{2\pi\sigma}} e^{-(z-\mu)^2/(2\sigma^2)} \tag{2}$$

Salt and pepper noise is an impulse type of noise, which is also referred to as intensity spikes. This is caused generally due to errors in data transmission. The probability of each is typically less than 0.1. The corrupted pixels are set alternatively to the minimum or to the maximum value, giving the image a "salt and pepper" like appearance. The salt and pepper noise is generally caused by malfunctioning of pixel elements in the camera sensors, faulty memory [4].

The PDF of bipolar impulse noise model is given by

$$pI(z) = \begin{cases} P_a & \text{for } z = a \\ P_b & \text{for } z = b \\ 0 & \text{otherwise} \end{cases}$$

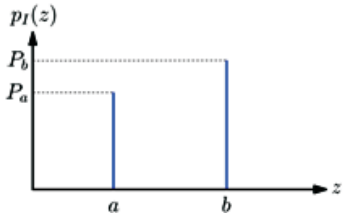


Figure 3. Probability density function $pI(z)$ of the bipolar impulse noise model.

If $b > a$, grey-level b appears as a light dot (salt) in the image. Conversely, a will appear as dark dot (pepper). If either P_a, P_b is zero, the PDF is called unipolar.

Because impulse corruption is generally large compared to the signal strength, the assumption is usually that a and b are digitized as saturated values thus black (pepper) and white (salt) [6,7].

4. Experimental Work

In this experimental study we have tested five remote sensing images successfully. The Gaussian noise and Salt & Pepper noise added as of figure 4 showing noisy remote sensing images. The denoising, deblurring, geometric and radiometric correction must be done in pre-processing levels. So, therefore image restoration is takes place as an important role in this investigation. Highly sophisticated skills are required for Remote sensing data centre when they doing pre-processing task at data centers. There are different types of noise will occurs in remote sensing images due to various reasons such as sensor calibration, cloudy atmosphere etc. but in this experimental study we have taken only two types of noises i.e. Gaussian & Salt and pepper. To analyze of the performance and interpretation the final results has shown below. Still removing noise from remote sensing image is challenging task without failure of all major quality aspect of images. So, Therefore Average, Median, Weiner and Unsharp filters have been used to denoising RS images. Moreover, Gaussian Noise and Salt & Pepper Noise have tested on in Remote sensing images and finally, using PSNR and L2rat statistically quality has measured.

Nomenclature of captions as fallows, RS: Remote Sensing, Gu: Gaussian Noise, AF: Average Filter, MF: Median Filter, WF: Weiner Filter, UF: Unsharp Filter, add: addition and SaP: Salt and Pepper Noise.

PSNR – This ratio is often used as a quality measurement between the original and a reconstructed image. The higher the PSNR, the better the quality of the reconstructed image.The performance is quantified by peak signal noise ratio. PSNR is an expression for the ratio between the maximum possible value (power) of a signal and the power

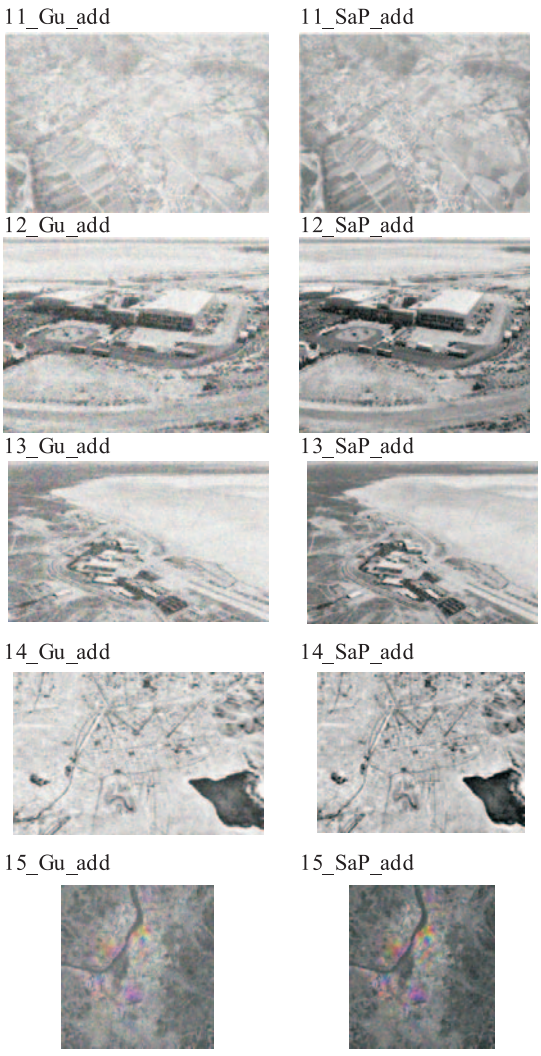


Figure 4. Adding noise in original remote sensing images.

of distorting noise that affects the quality of its representation. L2RAT-The ratio of the squared norm of the signal or image approximation to the input image. As below in the table 1 showing the performance of filters, Gaussian noise with all original, added and filtered noisy remote sensing images with quality measure in statistics.

Still removing noise from remote sensing image is challenging task without failure of all major quality aspect of images. So, Therefore Average, Median, Weiner and Unsharp filters have been used to denoising RS images. Moreover, Gaussian Noise and Salt & Pepper Noise have tested on in remote sensing images and using PSNR and L2rat statistically quality has measured.

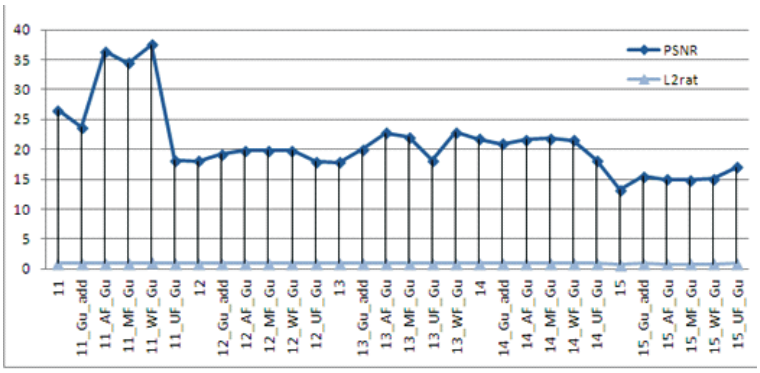
And table 2 showing the performance of filters, Salt and pepper Noise with all original, added and filtered noisy remote sensing images with quality measure in statistics. To carry experiment used MATLAB 2012a.

Table 1. The performance of filters on Gaussian Noise and quality measures in PSNR and L2rat.

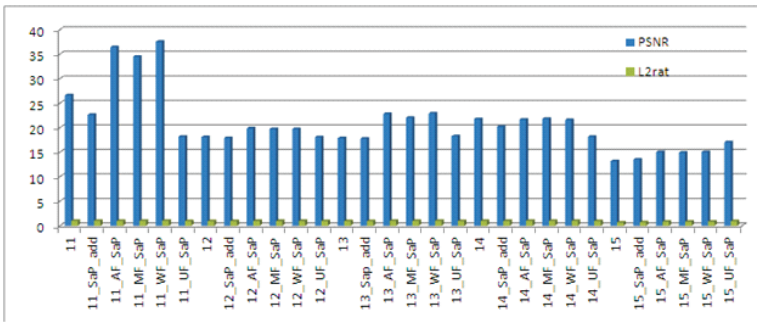
Gaussian Noise								
RS Images	PSNR	L2rat	RS Images	PSNR	L2rat	RS Images	PSNR	L2rat
11	26.6018	0.9949	12	18.0719	0.9567	13	17.8708	0.9583
11_Gu_add	23.6992	0.9922	12_Gu_add	19.1995	0.9743	13_Gu_add	20.0509	0.9804
11_AF_Gu	36.4089	0.9996	12_AF_Gu	19.8658	0.9768	13_AF_Gu	22.7843	0.9890
11_MF_Gu	34.4778	0.9994	12_MF_Gu	19.7418	0.9770	13_MF_Gu	22.0229	0.9874
11_WF_Gu	37.5196	0.9997	12_WF_Gu	19.7335	0.9760	13_WF_Gu	22.9358	0.9894
11_UF_Gu	18.1721	0.9661	12_UF_Gu	18.0418	0.9626	13_UF_Gu	18.2426	0.9656
14	21.7678	0.9837	15	13.1923	0.6784			
14_Gu_add	20.9265	0.9845	15_Gu_add	15.5269	0.8908			
14_AF_Gu	21.6558	0.9864	15_AF_Gu	14.9902	0.8585			
14_MF_Gu	21.8004	0.9873	15_MF_Gu	14.8381	0.8544			
14_WF_Gu	21.5698	0.9860	15_WF_Gu	15.0252	0.8585			
14_UF_Gu	18.1764	0.9654	15_UF_Gu	17.0351	0.9382			

Table 2. The performance of filters on salt and pepper noise and quality measures in PSNR and L2rat.

Salt and Pepper Noise								
RS Images	PSNR	L2rat	RS Images	PSNR	L2rat	RS Images	PSNR	L2rat
11	26.6018	0.9949	12	18.0719	0.9567	13	17.8708	0.9583
11_SaP_add	22.6381	0.9871	12_SaP_add	17.8912	0.9548	13_Sap_add	17.7762	0.9572
11_AF_SaP	36.4089	0.9996	12_AF_SaP	19.8658	0.9768	13_AF_SaP	22.7843	0.9890
11_MF_SaP	34.4778	0.9994	12_MF_SaP	19.7418	0.9770	13_MF_SaP	22.0229	0.9874
11_WF_SaP	37.5196	0.9997	12_WF_SaP	19.7335	0.9760	13_WF_SaP	22.9358	0.9894
11_UF_SaP	18.1721	0.9661	12_UF_SaP	18.0418	0.9626	13_UF_SaP	18.2426	0.9656
14	21.7678	0.9837	15	13.1923	0.6784			
14_SaP_add	20.1913	0.9765	15_SaP_add	13.4836	0.7178			
14_AF_SaP	21.6558	0.9864	15_AF_SaP	15.0239	0.8599			
14_MF_SaP	21.8004	0.9873	15_MF_SaP	14.8832	0.8563			
14_WF_SaP	21.5698	0.9860	15_WF_SaP	15.0223	0.8586			
14_UF_SaP	18.1764	0.9654	15_UF_SaP	17.0440	0.9385			



Graph 1. The Gaussian noise and filters results.



Graph 2. The salt & pepper noise and filters results.

Graph 1: The Gaussian Noise and filters results; the graph shows removal of noise at higher quality. When Gaussian noise is present in RS images then with the help of Average filter, Median filter and Weiner filters are removed Gaussian noise successfully as shown in graphical representation. But at the same time, Unsharp filter gives very lower quality.

Graph 2: The Salt and Pepper Noise and filters results; this graph shows the noisy images removed noise at higher level. The Salt & pepper noise has removed successfully from noisy Remote Sensing images with the help of Average filter, Median filter, Weiner filter and Unsharp filters are the best one to denoising the RS imagery at max level.

5. Conclusion and Future Work

In this paper we are address the issue of noise which is introduced into data by the sensor, environment features etc. And an empirically studied we have taken five remote sensing images and shown the performance of Average filter, Median filter, Weiner filter and Unsharp filters on Gaussian noise & Salt and pepper noise affected images. Hence, After experimental results states that when Gaussian Noise is exist in the RS Imagery then Average filter, Median filter, Weiner filter are the best one to denoising the remote sensing imagery at max level. But at the same time, Unsharp filter gives very lower quality. So, as far as Salt & Pepper noise is Concern that Salt & Pepper Noise is exists in the remote sensing imagery then Average filter, Median filter, Weiner filter and Unshap filter are the best one to denoising the imagery at max level. The future scope of this work is a variation in the sensor output that interferes with our ability to extract scene information from an image. Image noise occurs in wide variety of forms and is often difficult to model; for these reasons, many noise reductions are ad hoc. It is beneficial to categories noise type and generalizes their descriptive. The Results confirm the insensitivity of random projection with respect to impulse noise. Thus, random projection proves a promising alternative to some existing methods in noise reduction.

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