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Fast Noise Suppression Algorithm for Removal of Noises in Remote Sensing Satellite Images

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Abstract: *Noise removal is one of the techniques in image processing. In this paper Fast Noise Suppression is used for gray scale images which are contaminated by Noise. Remote sensing images are affected by different types of Noise like Gaussian Noise, Speckle Noise and impulse Noise. In this paper Traditional Median filter and Fast Noise Suppression Algorithm is used for reducing the Noise rate, when compare to some other filters. In this the Proposed Fast Noise Suppression Algorithm gives better results when compared to Traditional Median filter.*

Key words: *Remote Sensing Image, Traditional Median filter, Fast Noise Suppression Algorithm, Gaussian Noise.*

I. INTRODUCTION

Remote sensing can be defined as gaining information about an object but without making physical contact with it [3]. The activities such as recording, observing, perceiving objects or events at faraway places can be done using remote sensing images. Even it helps us to collect data on dangerous or inaccessible areas also [3]. The two types of remote sensing are passive remote sensing and active remote sensing. Passive sensor spots the natural emissions which are reflected by the object or by the areas around. Sunlight reflection is the most common source of rays that is measured by passive sensors [2].

Image data recorded by sensors on a satellite or aircraft contain errors related to geometry and brightness values of the pixels. The errors are corrected using suitable(filters) mathematical models. There are so many filters which can be used to reduce Noise a) Weighted Median Filterb) Standard Median Filter c)Adaptive Median filter, d)Wiener Filter and e)Kalman filter. Weighted Median Filter(WMF) selectively gives the multipreserving in the image structure than a median filter. Weighted Median Filter(WMF) is a natural extension of the median filter and has the same advantage of the median filter. Median filter is a simple and powerful non-linear filter, based on statistics and easy to implement for smoothing the image. That is reducing the amount of intensity variation between one pixel and the next Pixel. It is often used to reduce Noise in images[3].

Standard Median Filter(SMF) is a non-linear, low pass filtering method which can be used to remove speckle Noise from an image. Standard Median Filter(SMF) is a simple rank selection filter that attempts to remove Noise from an image by changing the luminance values of the center pixel of the filtering window[4]. Adaptive Median Filter(AMF) has been applied widely as an advance method compared with standard median filter. Adaptive Median Filter perform spatial processing to determine which pixels in an image have been applied by impulse Noise. Adaptive Median Filter classifies pixels as Noise by comparing each pixel in the image to its surrounding neighbour pixel. The size of the neighborhood is adjustable as well as the threshold for the comparison[5]. Adaptive Median Filter(AMF) is designed to eliminate the problems faced by the standard median filter. In this paper Fast Noise Suppression Algorithm and Traditional Median filter is used to reduce the Noise rate, when compare to other filters.

II. METHODOLOGY

Noise removal is one of the techniques in image processing. There are various types of Noise in image that can corrupt images. Some of the Noise are gaussian Noise, speckle Noise and salt and pepper Noise. Here the proposed work is represented the architecture as shown the fig-1

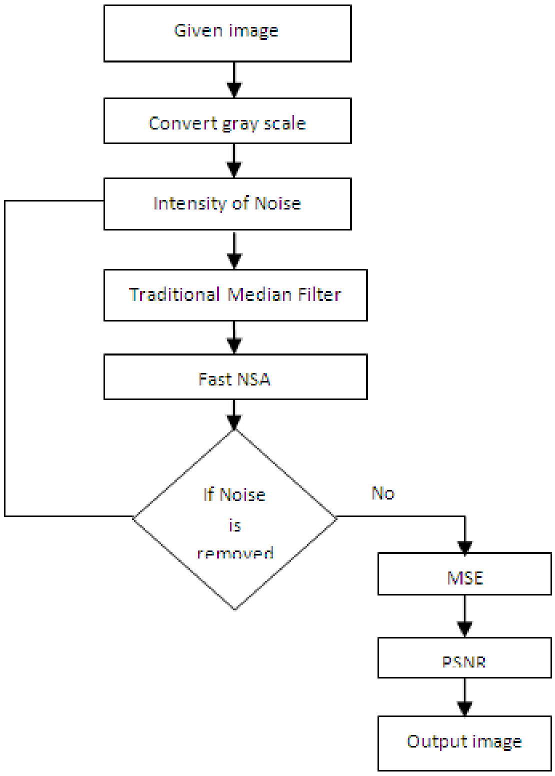

Fig-1 System Architecture

A. GAUSSIAN NOISE

This type of Noise is also called the normal Noise that is randomly occurs as white intensity values. Gaussian distribution Noise can be expressed by

$$P(x) = 1/ (\sigma\sqrt{2\pi}) *e^{(x-\mu)2} /2\sigma^2$$

When P(x) is the Gaussian distribution Noise in an image, μ and σ is the mean and standard deviation respectively.

B. SPECKLE NOISE

Speckle Noise is a ubiquitous that limits the interpretation of optical coherence of remote sensing image. The Noise can be expressed by

$$J = I + n*I$$

Where J is the distributed speckle Noise image, I is the input image and n is the uniform image.

C. SALT & PEPPER NOISE

This type of Noise contains random occurrences of both black & white intensity values, and often caused by threshold of Noise image. Salt & Pepper distribution Noise can be expressed by

$$P(x) = \begin{cases} p1, & x = A \\ p2, & x = B \\ 0, & otherwise \end{cases}$$

Where P_1, P_2 are the Probabilities Density Function (PDF) p(x) is the distribution salt and pepper Noise in image and A, B are the array size image. In this paper salt & pepper Noise in the image is randomly occurred in white and black pixels of an image [6]. The main challenge in removing salt & pepper Noise from image is due to the fact that image data as well as the Noise, share the same small set of values, which complicates the process of detecting and removing the Noise.

III. TRADITIONAL MEDIAN FILTER

There have been several variation on the median filter for example the Weighted Median Filter(WMF) selectively gives the neighbouring pixels multiple entries to the ordered list, usually with the centre pixels of the neighbourhood contributing more entries. The higher the weighting given to the central pixels, the better filter is at preserving corners, but less the smoothing effects [2]. The other methods include the Standard Median Filter (SMF) and Adaptive Median Filter (AMF). Standard Median Filter(SMF) is a non-linear, low pass filtering method which can be used to remove speckle noise from an image. Standard Median Filter(SMF) is a simple rank selection filter that attempts to remove noise from image by changing the luminance values of the center pixel of the filtering window[6]. Adaptive Median Filter(AMF) has been applied widely as an advance method compared with standard median filter. Adaptive Median Filter perform spatial processing to determine which pixels in an image have been applied by impulse noise. Adaptive Median Filter classifies pixels as noise by comparing each pixel in the image to its surrounding neighbour pixel. The size of the neighborhood is adjustable as well as the threshold for the comparisson. Adaptive Median Filter(AMF) is designed to eliminate the problems faced by the standard median filter[7].

Median Filter is one of the most popular nonlinear filters for removing salt & pepper noise [5]. Median filter is the non-linear filter which changes the image intensity value if the spatial noise distribution in the image is not symmetrically within the window. It is useful for removing isolated lines or pixels while preserving spatial resolutions. Median filter is a spatial filtering operation, so it uses a 2D mask that is applied to each pixel in the input image. To apply the mask means to centre it in a pixel, evaluating the covered pixel brightness and determining which brightness value is the median value. The pixel with the median magnitude is used to replace the pixel.

Median filter = (x1, x2, x3.....xn) = median(x1, x2, x3...xn)

There are two classes of median filter such as 1-dimensional and 2-dimensional. We will primarily interest in the 1-D case. In the 1-D case we have an input stream of values x_0, x1, x2 ... which is encoded as 1 bit integers. We denote the window centre on the *i* th value as $W_i = \{x_{i-N} \ldots . x_i \ldots . . x_{i+N}\}$ on each step, oldest element x_{i-N} must be eliminated as new element x_{i+N} arrives [8]. In this paper traditional median filter and Fast Noise Suppression filtering Algorithm is used for reduce the noise rate, when compare to this filter and algorithm Fast Noise Suppression gives better results.

IV. IMAGE NOISE MODEL

For simplification, the new approach to de-noising is based on the assumption that each digital image $I[n,m]$ with a dynamic range of $[0:2^{b-1}]$ consists of an original version $I_o[n,m]$ with a gain C and additive white noise $Z[n,m]$ introduced by the image recording process

$$I[n,m] = I_o[n,m].C + Z[n,m], \quad 0 \le Z[n,m] < D$$

Where by the noise is distributed in the interval$[0;D]$. Let $D \le 2^P \le C$ with$P \in Z(P \ge 0)$, and then it is obvious that the uncertainty of grey values is located in the lower $0 \le b < P$ bit planes of $I[m,n]$. Even if $D > C$ holds, the noise is concentrated in the lower planes. The idea behind the new method is now to detect all bit planes containing only noise without any significant image information and to cut them. This recovers the original image $I_o[n,m]$ and gives full control over the de-noising process [12].

V. FAST NOISE SUPPRESSION FILTER

The b bit-planes can be regarded as a uniform quantization

$$I_D[n,m] = \left[\frac{I[n,m]}{2^b}\right].2^b + [2^{b-1}]$$

For best coding results, the addition of $[2^{b-1}]$ and the multiplication by 2^b should be moved to the decorder stage.

The visibility of de-noising effects depends on the relation of dynamic range and the number of detected noisy bit-planes [11][12]. To keep a minimum of the image characteristic, even if it ontains mainly noise, it makes sense to limit the maximum number of bit-planes. The salt and pepper noise was created by choosing a fraction of the image to corrupt and then setting the pixels to be corrupted to random brightness in the range 0 to 255. The filter clearly integrates the best aspects of the existing noise reduction and it gives the very good results.

VI. IMAGE QUALITY MEASUREMENTS

A. Mean Square Error (MSE)

The simplest of image quality measurement is Mean Square Error (MSE). The large value of MSE means that image is poor quality. MSE is defined as follow:

$$\text{MSE} = \frac{1}{MN} \sum_{m=1}^{M} \sum_{n=1}^{N} \left(x(m,n) - \hat{x}(m,n)\right)^2$$

B. Peak Signal to Noise Ratio (PSNR)

The small value of Peak Signal to Noise Ratio (PSNR) means that image is poor quality. PSNR is defined as follow:

$$\text{PSNR} = 10\log\frac{255^2}{MSE}$$

VII. RESULTS

The figure2 shows the experimental results of the proposed work. The test image is taken as Input image. It has very high frequency components, so the median filters and fast NS filter is used to reduce Noise in the Image. Both of the Filters leaves lots of residual Noise. When compared to the Median filter, Fast NS filter produces better intensity level when compared to wiener filter which is shown in fig2.This shows that the Fast Noise Suppression filter has shown good efficiency in noise filtering. The proposed work is done using MATLAB. 2010 version.

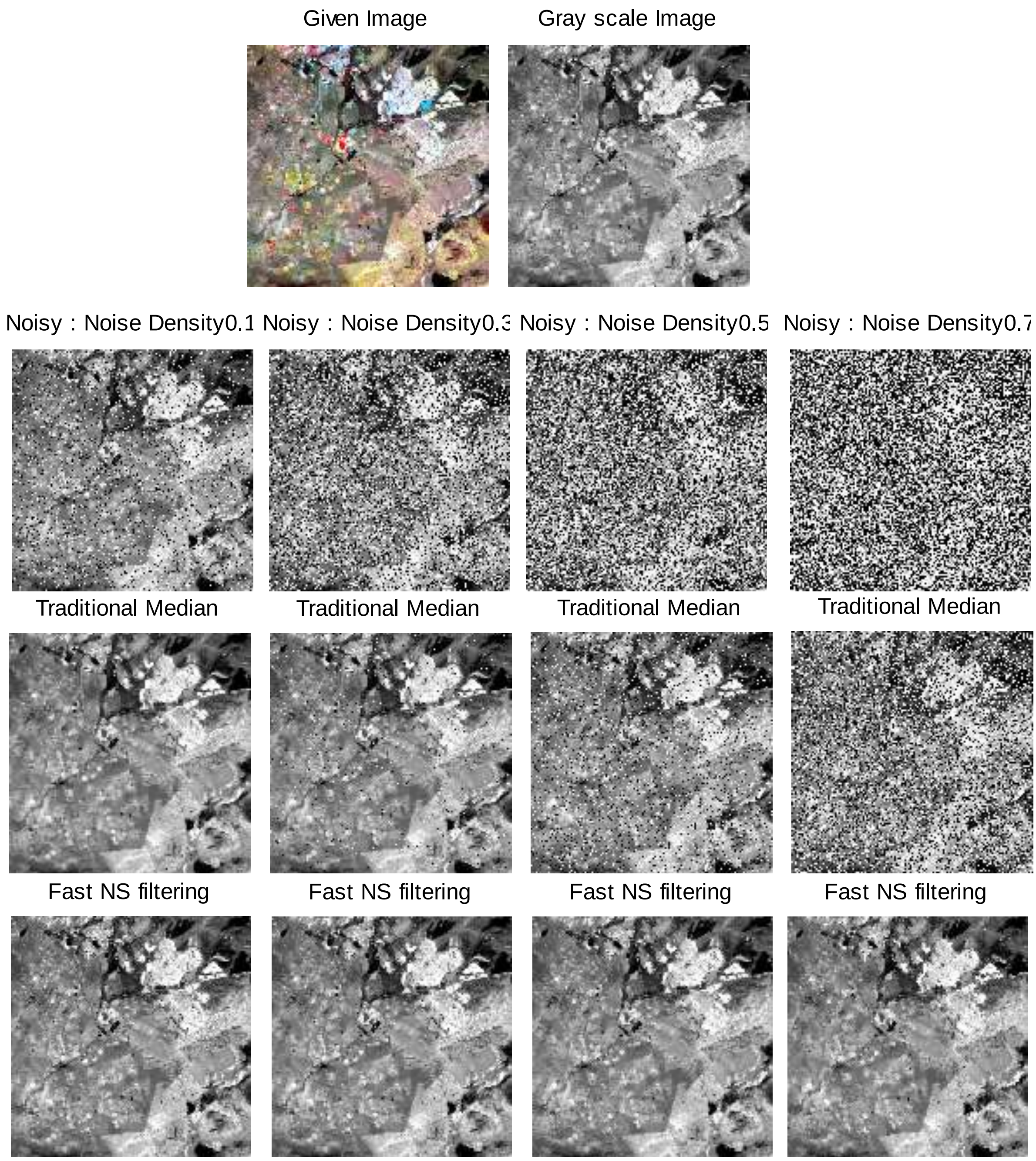

Fig 2: Intensity level for Median and Fast NSA

Table 1: Results of MSE & PSNR Value for Median Filter & Fast NSA

Noise Density	Traditional Median Filter		Fast NSA	
	MSE	PSNR	MSE	PSNR
0.1	3.8147e-008	122.3162	1.2716e-008	127.0874
0.2	1.5359e-007	116.2956	5.0863e-008	121.0668
0.3	3.4332e-007	112.7738	1.1444e-007	117.5450
0.4	6.1035e-007	110.2750	2.0345e-007	115.0462
0.5	9.5367e-007	108.3368	3.1789e-007	113.1080
0.6	1.3733e-006	106.7532	4.5776e-007	111.5244
0.7	1.8692e-006	105.4142	6.2307e-007	110.1855

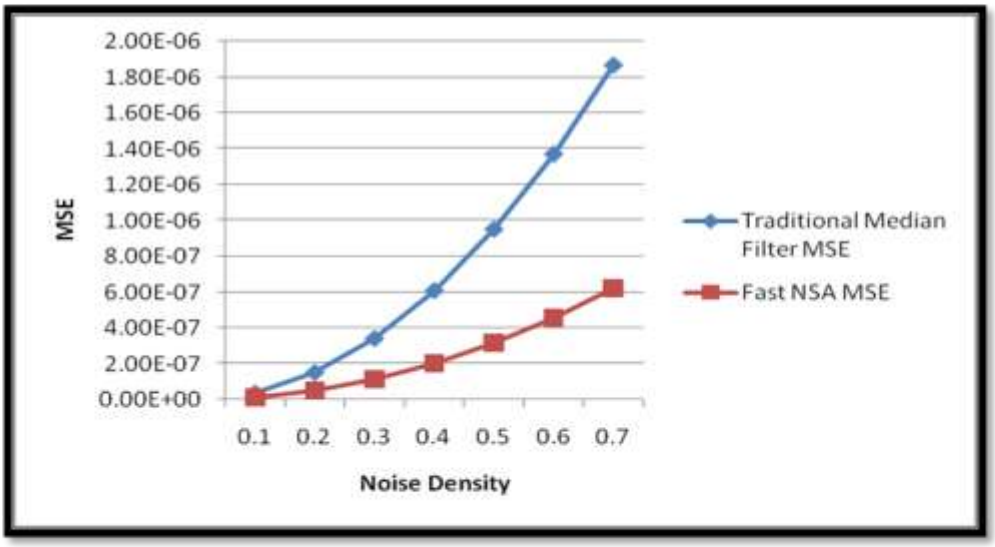

Fig 3: Comparison of MSE in Median Filter & Fast NSA

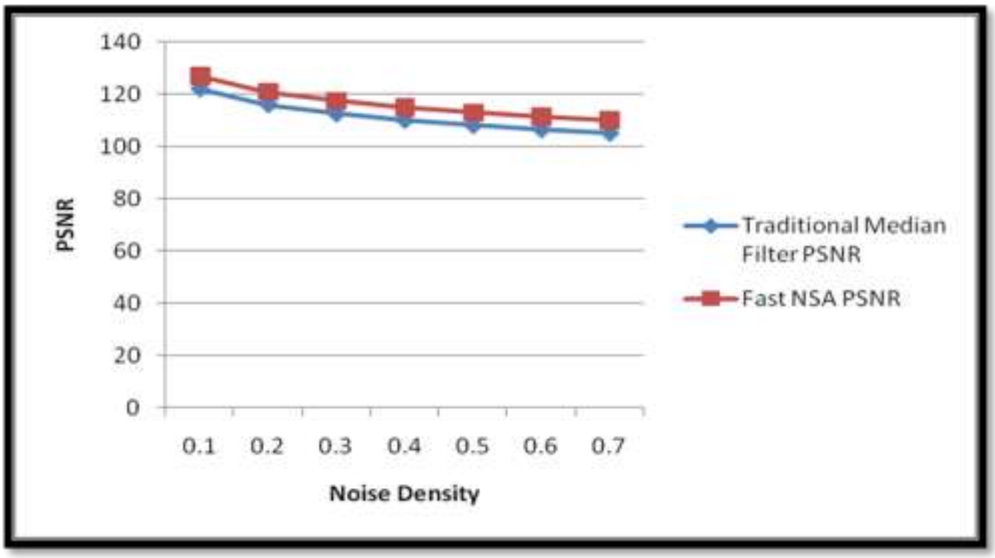

Fig 4: Comparison of PSNR in Median Filter & Fast NSA

VIII. CONCLUSION

Noise removal is a major problem in Remote sensing Images. The image captured by the sensor undergoes filtering by different smoothing filters and the resultant image is fused to attain high quality image. This paper has described a new principle of Noise reduction in order to preserve the image structure. While capturing the Remote Sensing image it usually have a Gaussian Noise, speckle Noise and salt & pepper Noise. Various filters are used to remove the Noise in the Image. In this proposed work we have used Median filter and Fast NSA filter to reduce the noise in the Image. Fast NS filter works well in reducing the Noise while preserving the underlying structure of an image when compare to the other said filter. Fast NSA filter performs large amount of Noise and shows better efficiency in filter.

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