Random Valued Impulse Noise Removal using Various Filters: A Review

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Abstract: Digital image processing is significant in many areas. Noise detection and rectification in digital images is beneficial in many areas .In this paper we survey on efficient method for the removal of random valued impulse noise. Here applying a detection process and a filtering process. Detection process detects the noisy pixels by using the absolute difference and median filter for filtering. Removal of random valued noisy pixel is extremely challenging when the noise density is above 50%. For rectification of impulse noise as well as preserve edge implements a new filter that is Dual Threshold Median Filter (DTMF). The main objective of this paper work is to detect and de-noise the image. The median values of the pixels which lie in the direction of minimum difference are calculated and the noisy pixel values are replaced with the median value.
Keywords: Pixel, DTMF, Noise detection etc

I. INTRODUCTION

In many practical applications images are corrupted by noise caused either by faulty image sensors or due to transmissions corruption resulting from artificial or natural phenomena. Transmission noise, also known as salt-and pepper noise in grey-scale imaging, is modeled by an impulsive distribution. Preservation of image details and suppression of noise are the two important aspects of image processing. . Nonlinear filter provide a better alternative solutions to linear filter, due to their effectiveness in reducing impulse noise.

To preserve edges, improve PSNR median filters are widely used. The centers of research are on the removal of impulse noise while minimizing the loss of details as low as possible. However, a problem in the study of the effect of the noise in the image processing community is the lack of commonly accepted multivariate impulse noise model.

Random valued impulse noise will generate impulses whose gray level values lies within a fixed range. The random-valued impulse noise is more difficult to remove due to the random

distribution of noisy pixel and its value lies between 0 and 255. Most of the filters related to image denoising have two stages namely a detection stage and a replacement stage. Detection stage detects noisy pixel while replacement stage replaces the noisy pixel by estimated value. Noise detection is a key part of a filter, so it is necessary to detect whether the pixel is noisy or noise free. Only noisy pixels are manipulated to de-noising processing and noise free pixels.

With the time many result oriented features are added in the standard median filters, there were so alternate filters which has been designed like weighted median filter, center weighted median filter (CWMF)[2] [3], progressive converting median filter (PSMF), signal rank order median filter (SDROM) [5], Recursive adaptive center weighted median filter (RACWM) and many other improved filters, here we propose a nonlinear dual median filter which removes random valued impulse noise without edge blurring.

The main approach for impulse noise removing is to use median-based filters [3]. However, these nonlinear filters also tend to modify pixels that are not affected by the noise. In addition, when impulse noise probability is high, they are prone to edge jitter, so that details and edges of the original image are usually blurred by the filter [6-11]. In order to improve performance of median-based filter approach, various decision-based filters have been proposed, where possible impulse noise pixels are first identified and then replaced by using median filter. The examples of decision-based filters for random-valued impulse noise removal from grayscale images are: adaptive center weighted median filter [10] and directional weighted median filter [11]. The most popular vector filter is vector median filter (VMF). VMF is a vector processing operator that has been introduced as an extension of scalar median filter [4, 5].

NOISE MODEL MECHANISM

Image noise is a random, usually unwanted, distortion in brightness or color information in an image. Image noise is most possible in image regions with low signal level, such as shadow region technique flow or underexposed pixels. Impulse noise is one of common type of noise present in images. There are two common kinds of the impulse noise square measure the Fixed-Valued Impulse Noise (FVIN), conjointly referred to as Salt and-Pepper Noise (SPN), and therefore the Random-Valued Impulse Noise (RVIN)[1]. They disagree within the potential values that vociferous pixels will take. The FVIN is often shapely by-

$$(Y_{ij}) = \begin{cases} X_{i,j} & \text{with probabilty } p \\ (0,255) & \text{with probabilty } 1-p \end{cases} \quad \text{.......... ....(1)}$$

Where $X_{i,j}$ and $Y_{i,j}$ denote the intensity worth of the initial and corrupted pictures at coordinates (i,j)

This model implies that the pixels square measure haphazardly corrupted by 2 mounted extreme values, i.e. 0 and 255, with an equivalent likelihood.A model is taken into account as below:

$$(X_{ij}) = \begin{cases} (0,m) & \text{with probabilty } p1 \\ X_{i,j} & \text{with probabilty } 1-p \\ (255-m,255) & \text{with probabilty } p2 \end{cases} \quad \text{.......... ..(2)}$$

Where p = p1 + p2. We refer to this model as Random valued Impulse Noise (RVIN)

VARIOUS TYPES OF FILTERS USED

A fundamental step in image processing is the step of removing various kinds of noise from the image. Sources of noise in an image mostly occur during storage , transmission and acquisition of the image. Image denoising is a applicable issue found in diverse image processing and computer vision problems.

The image s(x,y) is blurred by a linear operation and noise n(x,y) technique is added to form the degraded image w(x,y). This is convolute with the restoration mechanism g(x,y) to produce the restored image z(x,y)

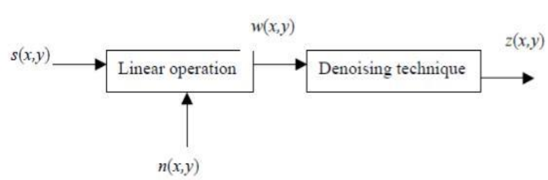

Figure: Denoising concept

There are different techniques to help restore an image from noisy distortions image data. The evaluation of each algorithm is compared by computing Signal to Noise Ratio (SNR) besides the visual interpretation mechanism.

Mean filter (M.F)

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The mean filter is a simple sliding-window spatial filter that replaces the center value in the window with the average(mean) of all the pixel values in the window. The window, or kernel, is usually square but can be of any shape.

Often a 3× 3 square kernel is used for this purpose. If the coefficients of the mask sum up to one, then the average brightness ratio of the image are not updated in the original image. If the coefficients sum to zero, the average brightness are lost, and it returns a dark image implementation. The mean or average filter works on the shift-multiply-sum principle mechanism.

Median Filter

The median filter is a nonlinear digital filtering mechanism, basically used to remove noise. It is particularly good for removing impulsive type noise from a signal. There are a number of variations of this filter, and a two-dimensional variant is often used in DSP systems to remove noise and speckles from images.

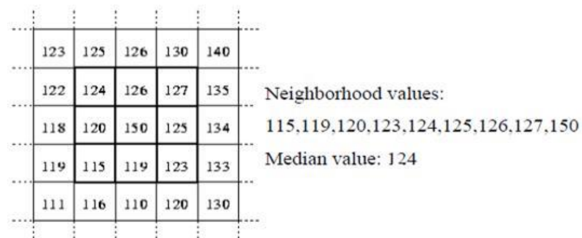
Median filters are useful in reducing random noise, especially when the noise amplitude probability density has large tails, and periodic patterns. The median filtering process is accomplished by sliding a window over the image. The filtered image is obtained by placing the median of the values in the input window, at the location of the center of that window, at the output image. The median is the maximum likelihood estimator of location in the case of Laplacian noise distribution[13]. For relatively uniform areas, the median filter estimates the gray-level value, with particular success in the presence of long-tailed noise. As an edge is crossed, one side or the other dominates the window, and the output switches sharply between the values. Thus, the edge is not blurred.

Assume that the pixel values in a neighborhood are taken in to sequence M1, M2, M3………... Mn. To achieving, the median value of pixels, first all pixels are arrange in ascending or descending order. After sorting these pixels, the arrangement will be Mi1≤Mi2≤Mi3≤................Min, in ascending order and Mi1 ≥ Mi2 ≥ Mi3 ≥................Min, in descending order.

Thus, mathematically median is representing as:

$$\text{Median (M)} = \text{Med}\{Mi\} = \begin{cases} Mi(n+1)/2, & \text{n is odd} \end{cases}$$

‗n' is generally odd.



123	125	126	130	140
122	124	126	127	135
118	120	150	125	134
119	115	119	123	133
111	116	110	120	130

Figure: Concept of median filtering

A median filter follows the class of nonlinear filters unlike the mean filter. The median filter also pursues the moving window principle similar to the mean filter technique. A 3× 3, 5× 5, or 7× 7 kernel of pixels is scanned over pixel grid technique of the complete image.
The central pixel value of 150 in the 3×3 window shown in above Figure is rather abnormal of the surrounding pixels and is replaced with the median value of 124. The median is most accurate compared to the mean.

Vector Median Filter

The processing of each image pixel consists of two stages: impulse detection and filtration, as shown in the figure The VMF-DD detector works as follows.

Let $\mathbf{x}_{ij}$ be the current pixel of the distorted image with coordinates (i, j) , $\mathbf{y}_{ij}$ - the corresponding pixel of the processed image. On the stage of detection four basic directions passing through the central pixel $\mathbf{x}_{ij}$ are chosen inside the filter sub-window. They are designated by indexes 1...4. For each direction two sums are calculated: the sum of brightness value differences dL_{ij}^{k} $(k\ 1...4)$ between pixels lying on the given direction $\mathbf{x}_{ij}{}^{k}$ and the central pixel $\mathbf{x}_{ij}$; the sum of angular distances dA_{ij}^{k} $(k\ 1...4)$ between pixels lying on the given direction $\mathbf{x}_{ij}{}^{k}$ and the central pixel $\mathbf{x}_{ij}$. The angular distance between two pixels we define as an angle between corresponding 3-channel vectors which contain color component values of pixels [21]:

$$\left| \mathbf{x}_1, \mathbf{x}_2 \right| \quad arc\cos \frac{\mathbf{x}_1, \mathbf{x}_2}{\|\mathbf{x}_1\|\|\mathbf{x}_2\|}$$

$$arc\cos \frac{x_{11}\,x_{21}\,x_{12}\,x_{22}\,x_{13}\,x_{23}}{x_{11}^2\,x_{12}^2\,x_{13}^2\,x_{21}^2\,x_{22}^2\,x_{23}^2}$$

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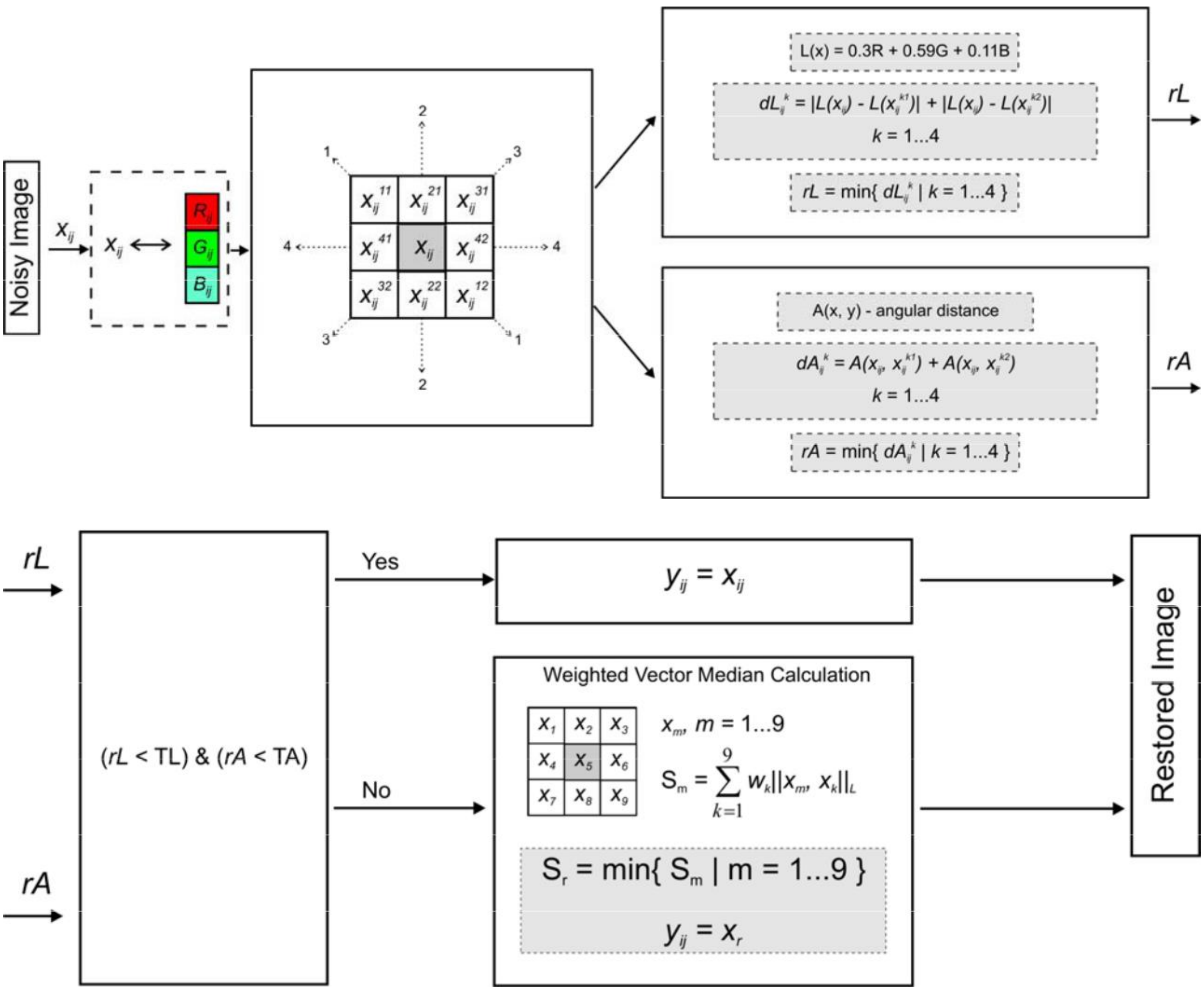

Figure: The scheme of vector median filter with directional detector

Adaptive median filter (AMF)

The Adaptive Median Filter performs spatial processing to determine which pixels in an image have been affected by impulse noise. The Adaptive Median Filter classifies pixels as noise by comparing each pixel in the image to its surrounding neighbor pixels. The adaptive median filtering mechanism has been implemented widely as an advanced method technique correlated with standard median filtering method[2]. First filter window size is determined according to the distance between the valid pixels and the center pixels in the proposed algorithm, which can avoid the waste of pixels repeated sort in window expand process. Second, the algorithm will only take the median value from valid pixels within the window. effectively weakening the interference with noise point, it will improve the quality of image.

A pixel that is contrasting from a majority of its neighbors, as well as being not structurally allocate with those pixels to which it is found same, is labeled as impulse noise. These noise pixels are then achieved by the median pixel value of the pixels in the nearest that have passed the noise labeling test mechanism.

CONCLUSION

Here we have discussed about different filtering methods in digital image processing. The advance filter has shown that it is very efficient for random valued impulse noise because analytically noise is not uniform over the channel in any aspect. We have utilized the concept of maximum and minimum threshold to identify both edges and noisy part of image. For future scope Dual Threshold Median Filter (DTMF) is all address of impulse noise removal for both low and high-density noise level with detail or edge preservation for getting better result.

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