An Efficient VLSI Design of Threshold Filter using Removal of Impulse Noise using Wallace Tree Encoder

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***Abstract*—**Impulse noise often corrupts the images in the procedures of image acquisition and transmission. Denoising of image corrupted by impulse noise is a prominent research area in Image Processing. To carry out noise suppression many denoising schemes introduced which uses standard median filter or its modifications. However, these approaches might blur the image since both noisy and noise-free pixels are modified. An studied denoising scheme called threshold filter and its VLSI architecture introduced to avoid the damage on noise-free pixels and also for the removal of high density impulse noise. Decision Tree Based Denoising method is performed as two phase process—a detection phase and a filtering phase. Noisy pixels will be detected by decision-tree-based impulse noise detector followed by a direction oriented edge-preserving median filter. Based on the probability distribution function of noise and SNR information obtained from the image, the filter uses selection of filtering window of size 3X3 to perform de-noising. The filtering technique has been implemented on MRI images. The efficiency of the proposed filtering technique is verified with a study of the PSNR characteristic of the de-noised and noisy image with respect to the true image. The proposed de-noising technique shows an improvement in the contrast ratio and PSNR of the noisy image.

Index Terms— Impulse Noise, Median Filter, De-noising

I. INTRODUCTION

A straightforward middle channel [1] works pleasantly to denoising rash commotion of low thickness and is anything but difficult to execute. Yet, the cost paid for it is twists edges and fine subtle elements of a picture. The contortion increment as the sifting window size is expanded to smother high thickness commotion. Middle Filter is a nonlinear sifting procedure broadly utilized for expulsion of motivation commotion [2]. In spite of its adequacy in smoothing commotion the middle channel tends to evacuate fine subtle elements when it is connected to a picture consistently. Be that as it may, some specific middle channels, for example, Weighted Median Filter [3] and Recursive Weighted Median Filter RWMF [4], Center Weighted Median Filter are proposed in writing to enhance the execution of the middle channel by giving more weight to some chose pixels in the sifting window.

The area images processing the two principal applications are the improvement of pictorial information for human interpretations. The way toward getting and investigating visual data by advanced PCs is called computerized picture preparing. A picture might be depicted as a two dimensional capacity f(p, q) where p and q are spatial directions. Sufficiency off at any combine of co-ordinates (p, q) is known as the force or dim level of the picture by then. The picture made out of a limited number of components each of which has a specific area and qualities. That implies the components of picture are pixels. Pixel is the term most broadly used to mean the components of computerized picture.

Performing some mechanical operation (robot motion) is the goal of the Image processing. In the Figure 1 typical blocks diagram of image processing system. This consists of the center part is the computer system, one image acquisition, image processing software, storage devices, transmitters and display devices. Advanced picture preparing has many preferences over simple picture handling. It permits a much more extensive scope of calculations to be connected to the info information, and can stay away from issues, for example, the development of clamor and flag contortion amid preparing [5].

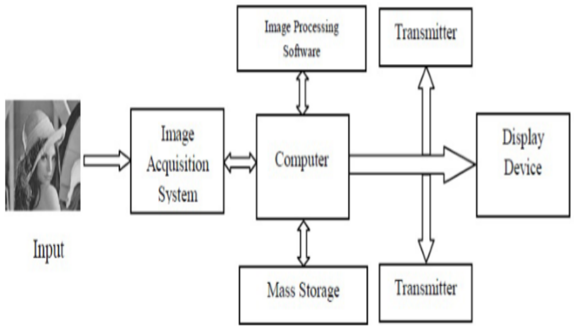


Figure 1: Typical Image Processing System

II. VARIOUS SORCES OF NOISE IN IMAGES

Noise is introduced in the image at the time of image acquisition or transmission. Different factors may be responsible for introduction of noise in the image. The number of pixels corrupted in the image will decide the quantification of the noise. The principal sources of noise in the digital image are: a) The imaging sensor may be affected by environmental conditions during image acquisition. b) Insufficient Light levels and sensor temperature may introduce the noise in the image. c) Interference in the transmission channel may also corrupt the image. d) If dust particles are present on the scanner screen, they can also introduce noise in the image.

DIFFERENT NOISE TYPES:-

Noise is the undesirable effects produced in the image. During image acquisition or transmission, several factors are responsible for introducing noise in the image. Depending on the type of disturbance, the noise can affect the image to different extent. Generally our focus is to remove certain kind of noise. So we identify certain kind of noise and apply different algorithms to remove the noise. Image noise can be classified as Impulse noise (Salt-and-pepper noise), Amplifier noise (Gaussian noise), Shot noise, Quantization noise (uniform noise), Film grain, on-isotropic noise, Multiplicative noise (Speckle noise) and Periodic noise.

Impulse Noise (Salt and Pepper Noise) :- The term impulse noise is also used for this type of noise [5]. Other terms are spike noise, random noise or independent noise. Black and white dots appear in the image [6] as a result of this noise and hence salt and pepper noise. This noise arises in the image because of sharp and sudden changes of image signal. Dust particles in the image acquisition source or over heated faulty components can cause this type of noise. Image is corrupted to a small extent due to noise. Show the effect of this noise on the original image (Fig 2).

Figure 2: Original image without noise, Image with salt & pepper noise

Gaussian Noise (Amplifier Noise):- The term normal noise model is the synonym of Gaussian noise. This noise model is additive in nature [7] and follow Gaussian distribution. Meaning that each pixel in the noisy image is the sum of the true pixel value and a random, Gaussian distributed noise value. The noise is independent of intensity of pixel value at each point.

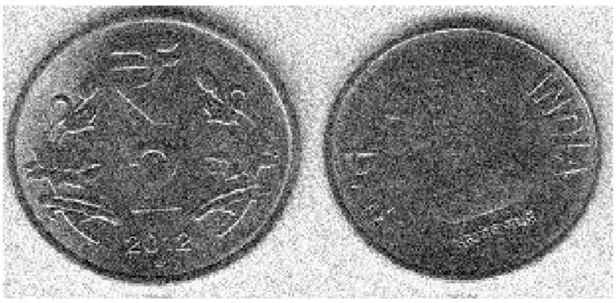


Figure 3: Gaussian noise

Poisson Noise (Photon Noise):-

Poisson or shot photon noise is the noise that can cause, when number of photons sensed by the sensor is not sufficient to provide detectable statistical information [4]. This noise has root mean square value proportional to square root intensity of the image. Different pixels are suffered by independent noise values. At practical grounds the photon noise and other sensor based noise corrupt the signal at different proportions [3].

Figure 4: Image with Poisson noise

Speckle Noise:-

This noise is originated because of coherent processing of back scattered signals from multiple distributed points. In conventional radar system this type of noise is noticed when the returned signal from the object having size less than or equal to a single image processing unit, shows sudden fluctuations.

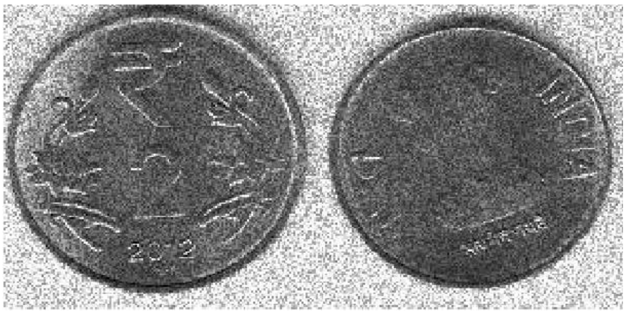


Figure 5: Image with speckle noise

III. MEDIAN FILTER

In sign processing, it's far often proper that allows you to carry out some type of noise reduction on a photograph or sign. The middle sift through is a nonlinear advanced separating system, every now and again used to evacuate commotion. Such clamor rebate is a normal pre-handling venture to enhance the results of later preparing (for instance, side location on a picture). Middle sifting could be generally utilized as a part of computerized photo processing due to the fact, beneath certain situations, it preserves edges even as doing away with noise (however see dialogue under).

The guideline idea of the middle get out is to gone through the sign section through get to, supplanting every passage with the middle of neighboring passages. The example of colleagues is known as the "window", which slides, access with the guide of access, over the total flag. For 1D sign, the most extreme clear window is essentially the essential couple of past and taking after sections, while for 2d (or higher-dimensional) cautions including photos, more intricate window examples are reasonable (which incorporate "holder" or "go" designs). Know that if the window has an odd wide assortment of passages, then the middle is anything but difficult to characterize: it is essentially the inside esteem after every one of the sections inside the window is sorted numerically. For an even wide assortment of passages, there is several suitable middle, see middle for additional data.

See that, in the case above, in light of the fact that there is no get to past the principal esteem; the essential expense is rehashed, as with a definitive charge, to procure adequate passages to fill the window. This is one method for adapting to lacking window passages at the hindrances of the flag, yet there are diverse plans that have outstanding houses that may be fancied particularly examples:

- Avoid handling the limits, with or without trimming the flag or picture limit a while later,
- Fetching sections from different places in the flag. With pictures for instance, sections from the far flat or vertical limit may be chosen,
- Shrinking the window close to the limits, so that each window is full.

Noise is added inside the picture at the time of photograph acquisition or transmission. Different factors may be accountable for introduction of noise inside the photo. The wide variety of pixels corrupted in the picture will decide the quantification of the noise. The fundamental assets of noise within the virtual image are:

a) The imaging sensor may be stricken by environmental conditions at some stage in picture acquisition.

b) Inadequate mild degrees and sensor temperature may additionally introduce the noise in the picture.

c) Interference in the transmission channel may also corrupt the photo.

d) If dirt debris is gift at the scanner display screen, they also can introduce noise inside the photograph.

Noise is the undesirable results produced within the picture. For the duration of photo acquisition or transmission, numerous elements are chargeable for introducing noise in the photo. Depending at the sort of disturbance, the noise can have an effect on the picture to special volume. Commonly our cognizance is to cast off sure kind of noise. So we become aware of sure type of commotion and apply one of a kind calculation to get rid of the clamor. Picture commotion can be sorted as Impulse clamor (Salt-and-pepper clamor).

IV. METHODOLOGY

Threshold filter has low computational complexity and requires only two line buffers instead of full images, so its cost of VLSI implementation is low. For better timing performance, we adopt the pipelined architecture to produce an output at every clock cycle. In our implementation, the SRAM used to store the image luminance values is generated with the 0.18µm TSMC/Artisan memory compiler, and each of them is 512×8 bits. According to the simulation results obtained from Design Ware of SYNOPSYS, we find that the access time for SRAM is about 5 ns. Hence, we adopt the 7-stage pipelined architecture for Threshold filter. The architecture adopts an adaptive technology and consists of five main blocks: line buffer, register bank, decision tree- based impulse detector, edge-preserving image filter and controller. Each of them is described briefly in the following subsections.

Algorithm:

Step 1: Select a 3 x 3 matrix size according to the 2-D window size. Assume that the processing pixel is P_{ij}, which lies at the center of window.

Step 2: If 0 < Pij< 255, then the processing pixel or Pij is uncorrupted and left unchanged.

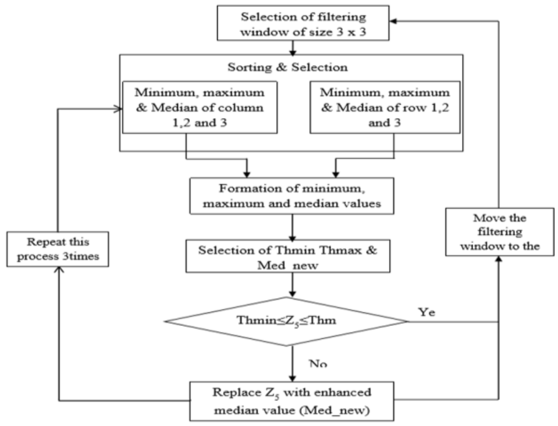


Fig. 6: Block Diagram of Threshold Filter

Step 3: On the off chance that Pij = 0 or Pij = 255, then it is considered as tainted pixel and four cases are conceivable as given underneath.

Case 1: In the event that the chose window has all the pixel esteem as 0, then Pij is supplanted by the Salt clamor (i.e. 255).

Case 2: On the off chance that the chose window contains all the pixel esteem as255, then Pij is supplanted by the pepper commotion (i.e. 0).

Case 3: In the event that the chose window contains all the esteem as 0 and 255 both. At that point the handling pixel is supplanted by mean estimation of the window.

Case 4: On the off chance that the chose window contains not all the component 0 and 255. At that point dispose of 0 and 255 and locate the middle estimation of the rest of the component. Supplant Pij with middle esteem.

Step 4: Rehash step 1 to 3 for the whole picture until the procedure is finished.

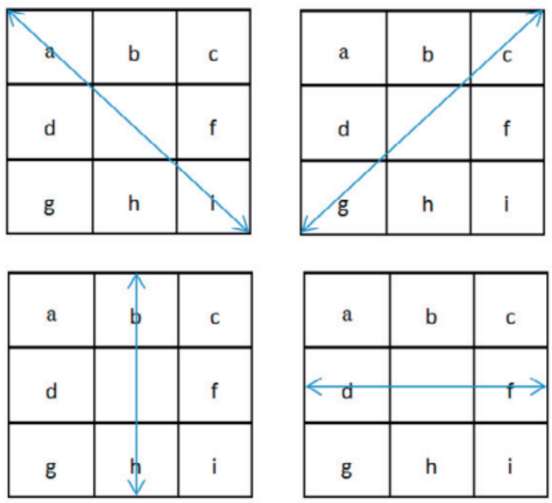


Figure 7: Read the Matrix

V. SIMULATION RESULT

The proposed calculations are tried utilizing 256x256 8bit/pixel picture bike.jpg. In the reproduction, pictures are tainted by Salt and Pepper commotion. The commotion level shifts from 10% to 90% with augmentation of 10% and the execution is quantitatively measured by Mean square Error (MSE) and Peak Signal to Noise Ratio (PSNR).

Mean Square Error (MSE)

$$= \frac{1}{N_1 N_2} \sum_{j=1}^{N_2} \sum_{i=1}^{N_1} (f(i,j) - g(i,j))^2 \quad (1)$$

Peak Signal to Noise Ratio (PSNR) in dB

$$= 10 \times \log_{10} \left(\frac{255^2}{MSE} \right) \quad (2)$$

Where MSE remains for Mean Square Error, PSNR remains for Peak Signal to Noise Ratio.

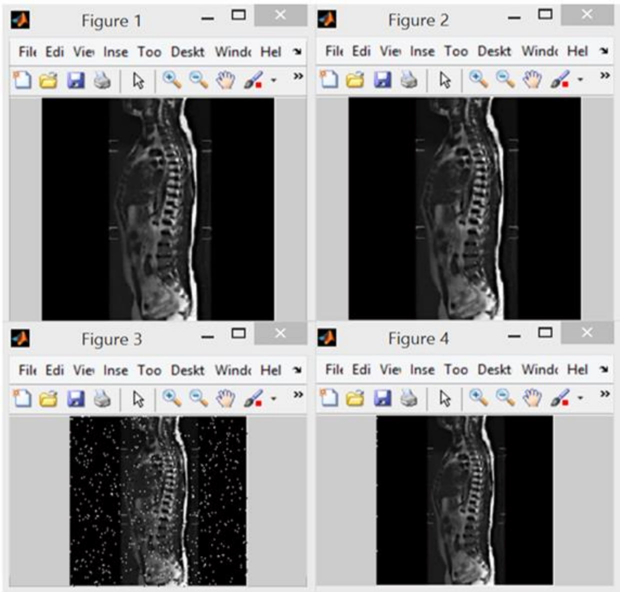
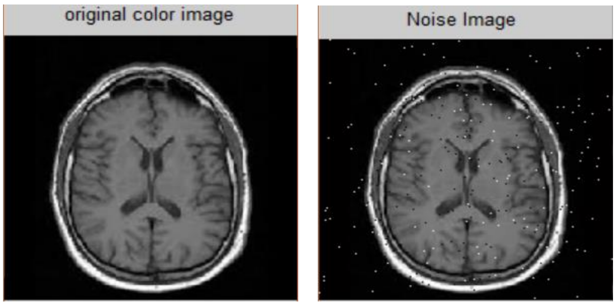


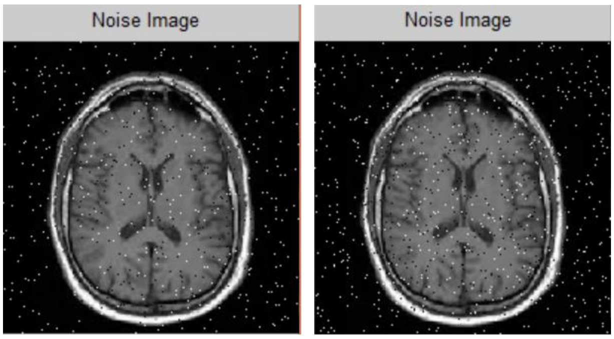
Figure 8: Experiment Result for MRI Spinal Cord Image with Salt and Pepper Noise

Table1: Comparison of different parameter with Different salt and Pepper Noise Density for Spinal Cord Image

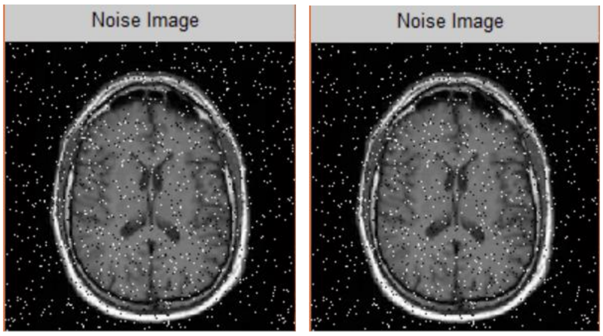
Noise Density (J/K)	NAE	MSE	RMSE	SNR	PSNR	UIQI
0.01	0.004	0.03	0.18	11.88	62.70	0.004
0.02	0.01	0.07	0.27	11.29	59.48	0.009
0.03	0.01	0.11	0.33	10.94	57.63	0.0014
0.04	0.02	0.15	0.38	10.67	56.35	0.0019
0.05	0.02	0.19	0.44	10.50	55.28	0.0023
0.06	0.03	0.24	0.49	10.34	54.32	0.0028
0.07	0.03	0.28	0.53	10.22	53.56	0.0033
0.08	0.04	0.32	0.57	10.08	53.03	0.0037
0.09	0.05	0.37	0.60	9.99	52.50	0.004



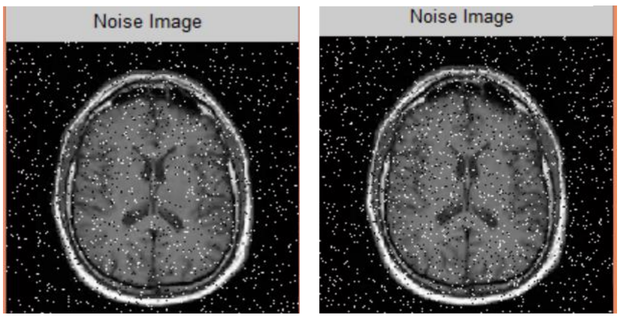
(a) Original Image (b) 0.01 Noise Density



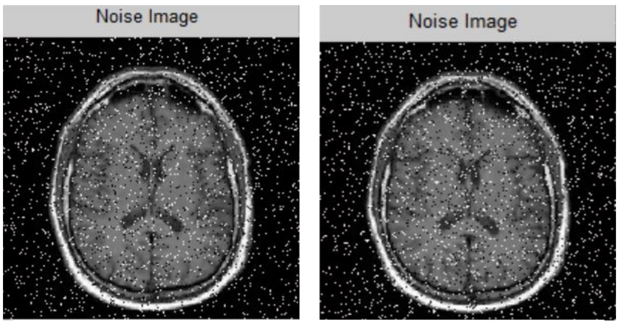
(c) 0.02 Noise Density (d) 0.03 Noise Density



(e) 0.04 Noise Density (f) 0.05 Noise Density



(g) 0.06 Noise Density (h) 0.07 Noise Density



(i) 0.08 Noise Density (j) 0.09 Noise Density

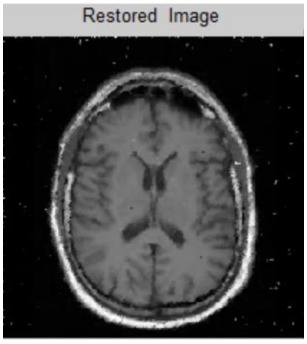


Figure 9: Experimental Salt & Pepper Noise Image for Different Noise Density

Table II: PSNR and MSE Value for Different Noise Density

Image Density	NAE	MSE	RMSE	PSNR (dB)
0.01	0.019	0.126	0.354	57.177
0.02	0.037	0.245	0.495	54.257
0.03	0.057	0.371	0.608	52.476
0.04	0.077	0.507	0.713	51.103
0.05	0.096	0.633	0.795	50.153
0.06	0.114	0.741	0.861	49.467
0.07	0.136	0.887	0.942	48.686
0.08	0.153	1.019	1.009	48.079
0.09	0.169	1.107	1.052	47.722

Table III: Comparison Result

Filter	PSNR (dB)	RMSE
Previous Algorithm	43.67	1.798
Proposed Algorithm	47.722	1.052

VI. CONCLUSION

A low-cost VLSI architecture for efficient removal of random- valued impulse noise is proposed in this paper. The approach uses the decision-tree-based detector to detect the noisy pixel and employs an effective design to locate the edge. With adaptive skill, the quality of the reconstructed images is notable improved. The proposed filter has proved that it is very efficient for random valued impulse noise because practically noise is not uniform over the channel. In this dissertation is used concept of maximum and minimum threshold to detect both positive and negative noise.

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