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Removal of Impulse Noise In Image Using Simple Edge Preserving Denoising Technique

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Abstract— Images are most often corrupted by impulse noise in the process of signal acquisition and transmission. Reducing noise has always been one of the standard problems of the image analysis and processing community. Even though, at the same time as reducing the noise in a signal, it is important to preserve the edges. Edges are of critical importance to the visual appearance of images. So, it is desirable to preserve important features, such as edges, corners and other sharp structures, during the denoising process. The proposed work presents an efficient implementation for removing impulse noise. The experimental results show that the proposed technique preserves the edge features and obtains excellent performances in terms of quantitative evaluation and visual quality. The design requires only low computational complexity and two line memory buffers. It's hardware cost is quite low. When compared with existing implementations, the proposed design achieves better image quality with less hardware cost. In images, impulse noise (salt &pepper) are introduced and PSNR and MSE values are checked. The Simple Edge-Preserved Denoising technique (SEPD) shows that better PSNR can be achieved.
Keywords— Signal acquisition, denoising, line buffer, SEPD, PSNR, MSE.

I. INTRODUCTION

Image processing is widely used in many fields, such as medical field, remote sensing, colour processing, robot vision, iris recognition, and so on. Images are often corrupted by impulse noise due to the occurrence of an error which is generated in the noisy sensor and communication channel. Hence, an efficient denoising technique is very important for the image processing applications. It is important to eliminate noise in the images before some subsequent processing, such as edge detection, image segmentation and object recognition. Many image denoising methods have been proposed to carry out the impulse noise suppression. In most reviews, standard median filter is used to implement the denoising process. The switching median filter [5] consists of two steps: 1) impulse detection and 2) noise filtering. It locates the noisy pixels with an impulse detector, and then filters them rather than the whole pixels of an image to avoid the damage on noise-free pixels. Generally, the denoising method for impulse noise suppression can be classified into two categories: lower complexity techniques and higher-complexity techniques. The intensity of impulse noise has the tendency of being either relatively high or relatively low. Thus, it could severely degrade the image quality and cause some loss of information details. In this paper, we focus only on the lower-complexity denoising techniques because of its simplicity and easy implementation with the VLSI circuit.

II. EXISTING SYSTEM

A. New Impulse Detector

In [6], a new impulse detector (NID) for switching median filter was used. By using 1-D Laplacian operators, NID obtain a minimum absolute value to detect noisy pixels. The image quality is determined by calculating mean square error (MSE). The computational complexity is high in this method.

B. Decision Based Algorithm

In [7], a decision-based algorithm (DBA) is used to remove the affected pixel by the median or by its neighbouring pixel value according to the proposed decisions. The picture quality is determined by calculating PSNR. The computational complexity is high.

C. Efficient Removal Of Impulse Noise

In [7], a method used to remove the impulse noise (ERIN) is based on simple fuzzy impulse detection technique.

III. PROPOSED SYSTEM

Based on less memory and few operation, a simple edge preserved denoising technique (SEPD) and its VLSI implementation for removing fixed-value impulse noise is proposed. The storage space needed for SEPD is two line buffers rather than a full frame

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buffer. Only simple arithmetic operations, such as addition and subtraction, are used in SEPD.

In SEPD, Assume that the current pixel to be denoised is located at coordinate (i, j) and denoted as P_{ij} ,and its luminance values before and after the denoising process are represented as f_{ij} and $f_{ij}^{`}$ respectively. SEPD is composed of three components: extreme data detector, edge-oriented noise filter and impulse arbiter.

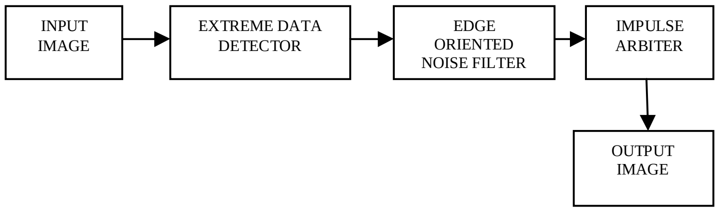

Fig. 1 Block Diagram

A. *Extreme Data Detector*

The extreme data detector detects the minimum and maximum luminance value in the image. If a pixel is corrupted by the fixed-value impulse noise, its luminance value will jump to the minimum or maximum value in gray scale. If fi,j is not equal to minimum or maximum value, it is concluded as Pi,j is noise-free pixel and the denoising process is skipped. If fi,j is equal to minimum or maximum value, its five neighbouring pixels are checked and then the result will be stored.

B. *Edge Oriented Noise Filter*

This is a new strategy for combining orientation adaptive filtering and edge preserving filtering. The filter which adapts to the local orientation avoids the filtering across the borders. The local orientation never contain two fields which can be achieved using generalised filtering. To locate the edge existed in the current W, a simple edge-catching technique which can be realized easily with VLSI circuit is adopted. To decide the edge, consider six directional differences, from D_1 to D_6 to avoid possible misdetection. Let M_{ij} represent the set of neighbouring pixels of P_{ij} within the 3x5 mask. If the value of pixels are corrupted by fixed value impulse noise then it will jump to a minimum or maximum value in a gray scale. Assume that F_{MIN} and F_{MAX} denote the minimum and maximum luminance values in M_{ij}. If P_{ij} is corrupted by impulse noise then F_{ij} will be much larger than F_{MAX} or less than $F_{MIN.}$

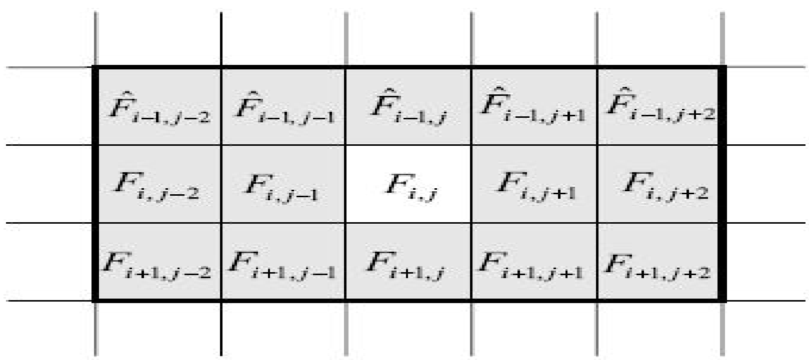

Fig. 2 Representation of Noisy Image Pixel

$$D1=F'_{i-1,j-2}-F_{i+1,j+2}$$
$$D2=F'_{i-1,j-1}-F_{i+1,j+1}$$
$$D3=F'_{i-1,j}-F_{i+1,j}$$
$$D4=F'_{i-1,j+1}-F_{i+1,j-1}$$
$$D5=F'_{i-1,j+2}-F_{i+1,j-2}$$
$$D6=F'_{i,j-1}-F_{i,j+1}$$

Parameters

$F_{i,j}$ = luminance value before de-noising process

$F'_{i,j}$= luminance value after de-noising process

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$F''_{i,j}$ =mean of luminance values of the two pixels

D1-D6 = Directions

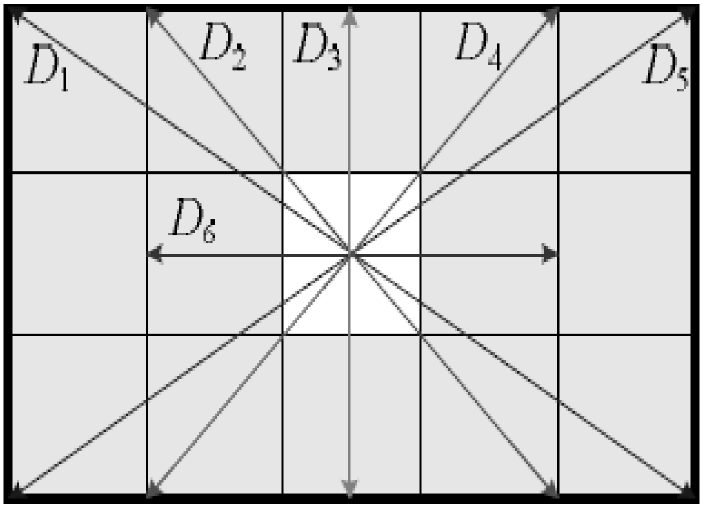

Fig. 3 Six Directional Difference

C. Impulse Arbiter

The value of a pixel, corrupted by the fixed-value impulse noise will jump to be the minimum or maximum value in gray scale. However, the converse is not true. Pixel with minimum or maximum luminance values might be identified as a noisy pixel even if it is not corrupted. To overcome this, additional condition is used to reduce the possibility of misdetection. If Pi,j is a noise free pixel and the current mask has high spatial correlation, fi,j should be close to fi,j and |fi,j – f"i,j| is small. So Pi,j might be a noise free pixel but the pixel value is small.

The value of |fi,j – f"i,j| is measured and compared with the threshold value to determine whether is corrupted or not. The threshold value denoted as T_S is a predefined value.

Obviously, the threshold value affects the performance of the proposed method. A more appropriate threshold value can achieve a better detection result. However, it is not easy to derive an optimal threshold value through analytic formulation. According to our experiment results, the threshold value is set to be 20.

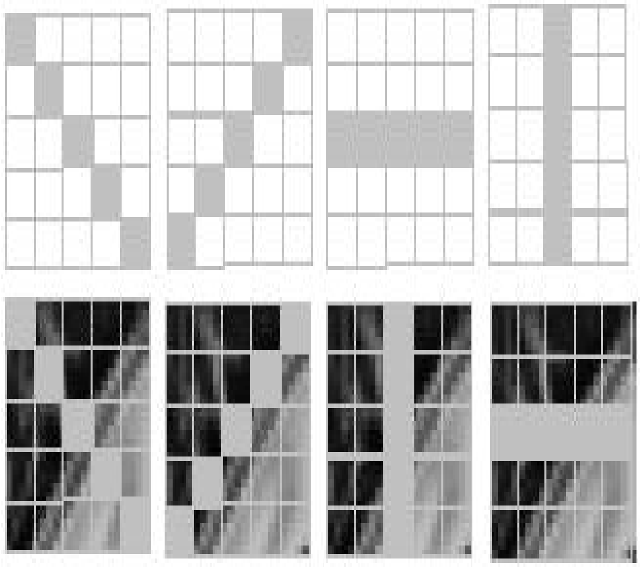

Fig.4 Example for Edge Oriented Noise Filter

IV. RESULT ANALYSIS AND COMPARISON

To verify the characteristics and performances of various denoising algorithms, a variety of simulations are carried out on the well-known 256 x 256 8-bit gray-scale Lena image. In the simulations, image is corrupted by impulse noise (salt-and-pepper noise), where “salt” and “pepper” noise are with equal probability. The peak signal to noise ratio (PSNR) is calculated to illustrate the quantitative quality of the reconstructed image. Table I shows PSNR value with impulse noise at various noise densities from 10% to 90% for the reference images. It can be observed from the results that the performances of the images processed by the proposed algorithm are always better.

TABLE I

COMPARISONS OF PSNR OF IMAGE “POUT”

NOISE DENSITY	DBA	SEPD
10%	33.1259	34.1077
20%	33.1148	34.1059
40%	33.1125	34.1036
50%	32.1065	34.0918
90%	32.0956	34.0865

V. SIMULATION RESULTS

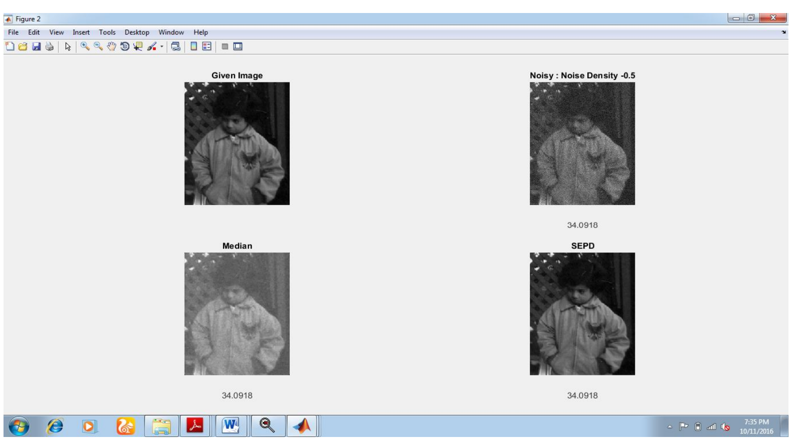

Fig.5 Results of SEPD in MATLAB, (a) Noise-free image; (b)Noisy image; (c)Median Filter output; (d) Edge Preserved output

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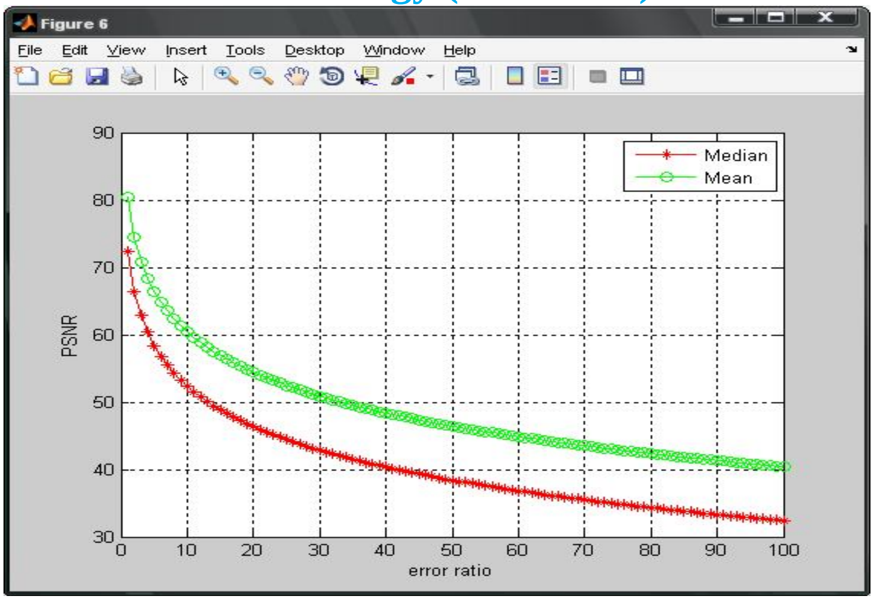

Fig.6 PSNR Vs Error value

VI. CONCLUSION

In this paper, the Matlab simulation for the removal of impulse noise is presented. The design requires only two line memory buffer and computational complexity is less, therefore the cost of implementation is less. The extensive experimental results shows that comparison of PSNR value of different algorithm achieves excellent performance in terms of quantitative analysis and visual quality, even when the noise ratio is as high as 90%.

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