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A Low Cost Implementation for Efficient Removal of Impulse Noise using Simple Edge Preserve Technique

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Abstract: **- In many applications, image and video signals are corrupted by impulse noise during acquisition or transmission. Hence there is a need for an efficient and consumer friendly impulse noise removal technique. In this paper, an efficient low cost VLSI architecture for the edge preserving impulse noise removal technique has been proposed. The architecture comprises of two line buffers, register banks, impulse noise detector, edge oriented noise filter and impulse arbiter. The storage space required for the proposed hardware is two line buffer rather than full frame memory. Moreover, proposed algorithm involves only fixed size window instead of variable window size. These two greatly reduces storage requirement as well as computation complexity. The impulse noise detector turns off the remaining circuitry if the current pixel is noise free, thus reducing power consumption. Further, the four stage pipeline architecture greatly improves the speed of operation. The implemented edge preserving algorithm results in better visual quality for denoised image. Thus the proposed architecture has less complexity, less storage requirement, low power consumption and improved speed of operation.**

Keywords: SEPD, Impulse Noise, line Buffer.

1.INTRODUCTION

In such a application as printing skills, medical imaging, scanning techniques, image segmentation and face recognition, images are often corrupted by noise in the process of image acquisition and transmission. Hence an efficient de-noising technique is very important for image processing. Many image de-noising methods have been proposed to carry out the impulse noise suppression to avoid the damage on the noise free pixel.

In general, the switching median filter consists of two steps are impulse detection and noise filtering. It locates the noisy pixels with an impulse detector and then filters them rather than they whole picture of an image to avoid the damage on noise free pixels. Simple Edge Preserved De-noising Technique (SEPD) is one the most important algorithm, which is used to remove the fixed value impulse noise, less storage memory is enough for SEPD technique. Only simple arithmetic operation such as addition and subtraction used in SEPD, the experimental result demonstrate that SEPD can obtain better performance in terms of both the quantitative evaluation and visual quality than other state of the art lower complexity impulse de-noising methods..

2.RELATED WORK:

A combination of adaptive vector median filter (VMF) and weighted mean filter is proposed for removal of high-density impulse noise from colour images. In the proposed filtering scheme, the noisy and non-noisy pixels are classified based on the non-causal linear prediction error. For a noisy pixel, the adaptive VMF is processed over the pixel where the window size is adapted based on the availability of good pixels. Whereas, a non-noisy pixel is substituted with the weighted mean of the good pixels of the processing window. The experiments have been carried out on a large database for different classes of images, and the performance is measured in terms of peak signal-to-noise ratio, mean squared error, structural similarity and feature similarity index. It is observed from the experiments that the proposed filter outperforms (∼1.5 to 6 dB improvement) some of the existing noise removal techniques not only at low density impulse noise but also at high-density impulse noise.

Images are often corrupted by impulse noise in the procedures of image acquisition and transmission. In this paper, we propose an efficient denoising scheme and its VLSI architecture for the removal of random-valued impulse noise. To achieve the goal of low cost, a low-complexity VLSI architecture is proposed. We employ a decision-tree-based impulse noise detector to detect the noisy pixels, and an edge-preserving filter to reconstruct the intensity values of noisy pixels. Furthermore, an adaptive technology is used to enhance the effects of removal of impulse noise. Our extensive experimental results demonstrate that the proposed technique can obtain better performances in terms of both quantitative evaluation and visual quality than the previous lower complexity methods. Moreover, the performance can be comparable to the higher complexity methods. The VLSI architecture of our design yields a processing rate of about 200 MHz by using TSMC 0.18 m technology. Compared with the state-of-the-art techniques, this work can reduce memory storage by more than 99 percent. The design requires only low computational complexity and two line memory buffers. Its hardware cost is low and suitable to be applied to many real-time applications.

3. PROPOSED TECHNIQUES

3.1simple Edge Preserved De-Noising Technique:

The storage space needed for SEPD is two line buffers rather than a full frame buffer. Only simple arithmetic operations, such as addition and subtraction, are used in SEPD. We proposed a useful impulse noise detector to detect the noisy pixel and employ an effective design to locate the edge of it. The experimental results demonstrate that SEPD can obtain better performances in terms of both quantitative evaluation and visual quality than other state-of-the-art lower-complexity impulse denoising methods.

Many noise filtering algorithms using diffusion equation have been proposed in recent years. They have a diffusion control term such as edge detector, which is based on the gradient of an initial image or successive filtered images by iteration. The diffusion control term decreases the diffusivity near the image features like edge or corners, and increases it in homogeneous region without them. The performance of filtering algorithms depends on the edge detector to some extent. However, the traditional noise filtering algorithms of diffusion equation use a simple edge detection method based on gradient of pixel values. Also, diffusion control term is re-estimated with successive filtered images in every iteration. These kinds of noise filtering algorithms still have a problem of blurring the image features.

The dislocation of edge also still remain the problem, because the edge detection used to control diffusivity is made in scale spaces. If each color channel is filtered separately, the filtered image would have the color distortion or blurring. That is because each channel has different level of pixel intensities near the image features such as edge or corners.

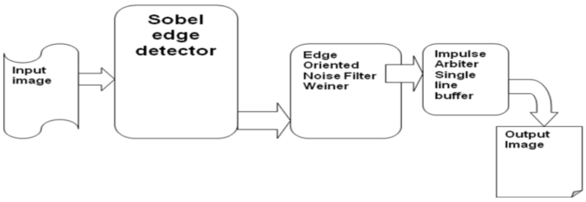


Fig 3.1 Block Diagram

3.3 Extreme Data Detector

The extreme data detector detects the minimum and maximum luminance values (MIN in w and MAX in w) in those processed masks from the first one to the current one in the image. If a pixel is corrupted by the fixed-value impulse noise, its luminance value will jump to be the minimum or maximum value in gray scale. If fi,j is not equal to luminance value we conclude that Pi,j is a noise-free pixel and the following steps for denoising Pi.j are skipped ,it is a fundamental tool in image processing and computer vision, particularly in the areas of feature detection and feature extraction, which aim at identifying points in a digital image at which the image brightness changes sharply or more formally has discontinuities.

In image processing the concept of feature detection refers to methods that aim at computing abstractions of image information and making local decisions at every image point whether there is an image feature of a given type at that point or not. The resulting features will be subsets of the image domain, often in the form of isolated points, continuous curves or connected regions.

3.4 Edge Oriented Noise Filter

This is new strategy for combining orientation adaptive filtering and edge preserving filtering. The filter adapts to the local orientation and avoids filtering across borders. The local orientation for steering the filter will be estimated in a fixed sized window which never contains two orientation fields. This can be achieved using generalized filtering. This filter selects from a set of fixed sized windows that contain the current pixel, the orientation of the window with the highest anisotropy.

We compare our filter strategy with a multi-scale approach. We found that our filter strategy has a lower complexity and yields a constant improvement of the SNR. Noise, which is present in every real world image hampers manual interpretation by human experts as well as automatic segmentation and analysis by computers. Therefore many image processing techniques are developed to reduce noise. The Wiener filter is the best linear filter but requires a priori knowledge of the spectrum of the noise-free image as well as the spectrum of the noise. Noise in domains without texture can simple be reduced by isotropic smoothing, where the spatial size of the smoothing operator determines the amount of noise reduction. So the size or scale of the domain constitutes the limit to this amount.

To optimize the global noise reduction, scale adaptive smoothing can be used. In an oriented texture domain or along individual lines and edges, the noise level can be reduced by applying elongated can be described as a collection of grey value and oriented texture domains, a scale and orientation adaptive smoothing scheme provides a powerful noise reduction method. Such a scheme can be realized in different ways, i.e. by anisotropic diffusion or steerable filters smoothing operators that adapt to the local orientation. This requires a robust and continuous representation of orientation . A simple edge catching technique which can be realized easily with MATLAB tool is adopted. To decide the edge, consider 6 directional differences, from d1 to d6 avoid possible misdetection. The resulting features will be subsets of the image domain, often in the form of isolated points, continuous curves or connected regions.

$\hat{F}_{i-1,j-2}$	$\hat{F}_{i-1,j-1}$	$\hat{F}_{i-1,j}$	$\hat{F}_{i-1,j+1}$	$\hat{F}_{i-1,j+2}$
$F_{i,j-2}$	$F_{i,j-1}$	$F_{i,j}$	$F_{i,j+1}$	$F_{i,j+2}$
$F_{i+1,j-2}$	$F_{i+1,j-1}$	$F_{i+1,j}$	$F_{i+1,j+1}$	$F_{i+1,j+2}$

Fig 3.2 Removal Of Noise

3.5.Six direction difference

We enlarge the mask of traditional median filter to 3×5, to get more pixels for finding the extreme data. Let Mi,j represent the set of those neighboring pixels of Pi,j within the 3×5 mask, Because the value of a pixel corrupted by fixed-value impulse noise will jump to be the minimum or maximum value in gray scale, we can detect the noised pixel by observing the variation between the minimum/maximum luminance values in Mi,j and the luminance value of target pixel (Fi,j). Assume that FMIN and FMAX denote the minimum and maximum luminance values in Mi,j. If Pi,j is corrupted by impulse noise, Fi,j will be larger than FMAX or less than FMIN much.

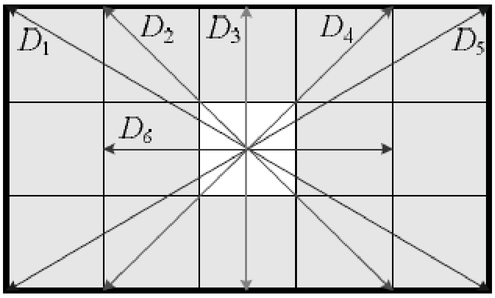


Fig 3.3 Six Direction Difference

we consider six edges in various directions. The six directional differences, denoted as D1-D6, are defined and calculated as follows:

D1=F`i-1,j-2-Fi+1,j+2
D2=F`i-1,j-1-Fi+1,j+1
D3=F`i-1,j-Fi+1,j
D4=F`i-1,j+1-Fi+1,j-1
D5=F`i-1,j+2-Fi+1,j-2
D6=F`i,j-1-Fi,j+1

Parameters

F i,j = luminance value before de-noising process
F`i,j= luminance value after de-noising process
F`i,j =mean of luminance values of the two pixels
D1-D6 = Directions

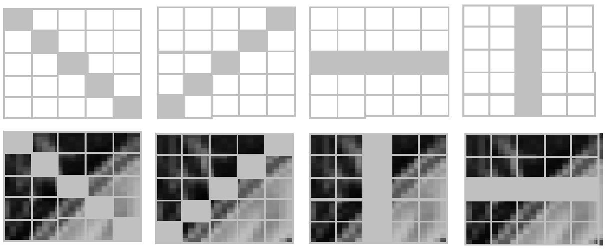


Fig 3.4 Example for Edge Oriented Noise Filter

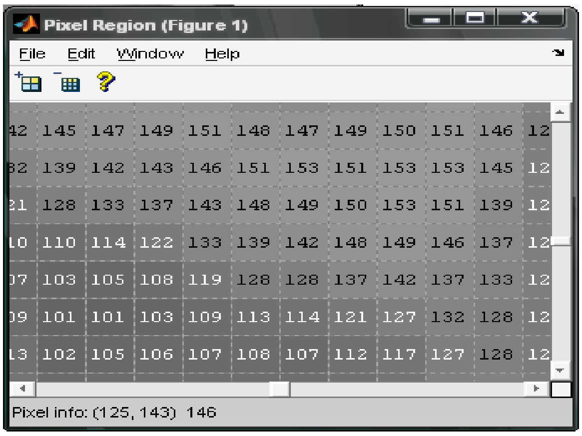
3.6 Impulse Arbiter

Since the value of a pixel corrupted by the fixed-value impulse noise will jump to be the minimum/maximum value in gray scale, we can conclude that if is corrupted, is equal to MIN in w or MAX in w. However, the converse is not true.

If fi,j is equal to MIN in w or MAX in w ,pi,j may be corrupted or just in the region with the highest or lowest luminance. In other words, a pixel whose value is MIN in w or MAX in w might be identified as a noisy pixel even if it is not corrupted. To overcome this drawback, we add another condition 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 f^ i,j and| |fi,j-f’’I,j| is small. That is to say, pi,j might be a noise-free pixel but the pixel value is or if is small. A more appropriate threshold can achieve a better detection result.

4. SIMULATION RESULTS

Grayscale images can be the result of measuring the intensity of light at each pixel according to a particular weighted combination of frequencies (or wavelengths).



42	145	147	149	151	148	147	149	150	151	146	12
82	139	142	143	146	151	153	151	153	153	145	12
21	128	133	137	143	148	149	150	153	151	139	12
10	110	114	122	133	139	142	148	149	146	137	12
07	103	105	108	119	128	128	137	142	137	133	12
09	101	101	103	109	113	114	121	127	132	128	12
13	102	105	106	107	108	107	112	117	127	128	12

Pixel info: (125, 143) 146

Figure 4.1: Pixel information of image

Each pixel is a sample of an original image; more samples typically provide more accurate representations of the original. The intensity of each pixel is variable. In color imaging systems, a color is typically represented by three or four component intensities.

It is a physical point in a raster image, or the smallest addressable element in an all points addressable display device; so it is the smallest controllable element of a picture represented on the screen. The address of a pixel corresponds to its physical coordinates. LCD pixels are manufactured in a two-dimensional grid.

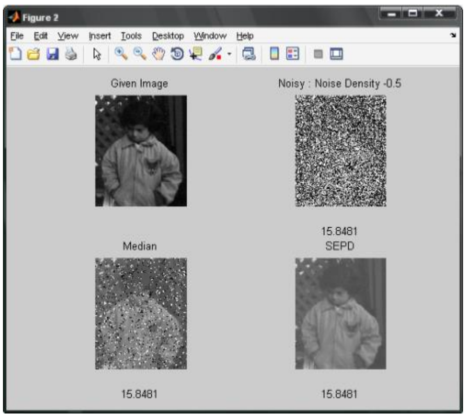


Figure 4.2 Performance SEPD compared with MEDIAN FILTER

It can be observed that the performances of SEPD are always the best, even the noise ratio is as high as 90%. to explore the visual quality, we show the reconstructed images of different de-noising methods in restoring60% corrupted image “pout” .

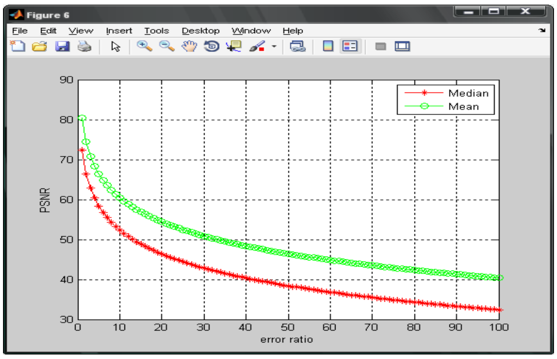


Figure 4.3: Error Ratio Vs PSNR

5.CONCLUSION AND FUTURE WORK

In this Project, an efficient VLSI implementation for impulse noise removal is presented. The extensive experimental results demonstrate that our design achieves excellent performance in terms of quantitative evaluation and visual quality, even the noise ratio is as high as 90%. For real-time applications, SEPD developed and implemented. As the outcome demonstrated, SEPD outperforms other technique with the lowest hardware cost. The architectures work with monochromatic images, but they can be extended for working with RGB color images and videos.

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