FPGA IMPLEMENTATION OF DECISION BASED ALGORITHM FOR REMOVAL OF IMPULSE NOISE

[1]Mr. Sanjay. P Patil1, [2]Mr. V.A Mane

[1]PG Student, [2]Assistant Professor
Department of Electronics and Telecommunication Engineering
Annasaheb Dange College of Engineering and Technology, Ashta, India

***Abstract*— Image processing is used in many fields like computer vision, remote sensing, medical imaging, robotics etc. Due to imaging systems, signal transmission, working environment and other external conditions, there would inevitably produce many kinds of noise, resulting in lower image quality. In most cases, impulse noise is caused by malfunctioning pixels in camera sensors, faulty memory locations in hardware, or errors in the data transmission. Two common types of impulse noise are - the salt-and-pepper noise (commonly referred to as intensity spikes or speckle) and the random-valued shot noise.**

***Index Terms*— Decision based algorithm, FPGA, Impulse Noise, Median filter**

I Introduction

For images corrupted by salt-and-pepper noise, the noisy pixels can take only the maximum or minimum values. In case of the random valued shot noise, the noisy pixels have an arbitrary value. It is very difficult to remove this type of noise using linear filters because they tend to smudge resulting images.

II .Impulse noise Model

The proposed decision based algorithm can filter the impulse noise. Consider an image I and an observation image X of same size

$$X_{ij} = \begin{Bmatrix} N_{i,j} \text{ with probabilty } p \\ I_{i,j} \text{ with probabilit y } 1 - p \end{Bmatrix}$$

Where i=1,2,…..s1 and j=1,2,…..s2 and 0<p<1. Iij and Nij denotes the pixel values at location (i,j) of the original image and the noisy image, respectively and Nij a noise value independent from Iij. For gray level images with 8 bits per pixel ,when the images are contaminated by fixed value impulse noise, Nij the corrupted pixel is equal to 0 or 255 each with equal probability (p/2).

III. Decision based algorithm

The Decision based algorithm is a nonlinear image smoothing technology, its main principle is that consider each pixel in the image as the center, build an odd number of samples (3 × 3, 5 × 5, 7 × 7, etc.) observation window around its neighboring area, sort the gray value of each point, and then use the median value instead of the original value. The key of the Decision based algorithm is to sort the value of each pixel in the observation window to obtain the median value. Also Decision based algorithm exhibits some advantages on previously developed non-linear filters as No reduction in contrast across steps, since output values available consist only of those present in the neighborhood (no averages). Median filtering does not shift boundaries, as can happen with conventional smoothing filters. Since the output pixel value is one of the neighboring values, new "unrealistic" values are not created near edges. Briefly Decision based algorithm can be explained with the following steps. Consider 3X3 window. First numbers are sorted vertically i.e. elements in each column in ascending order. Next numbers are sorted horizontally i.e. sort elements in each row in ascending order. One can observe that median is always a diagonal element. In step three sorts the cross diagonal elements, and pick up the median element. This median is median of nine elements and discards other elements.

Decision based algorithm can be implemented using median filter.

IV. Relevance

In the past years linear filters are became the most popular filters in image signal processing The reason of their popularity is caused by the existence of robust mathematical models which can be used for their analysis and design. However their exist many areas in which the non-linear filters lies in their ability to preserve edges and suppress the noise without loss of details [3][6]. The success of non-linear filters is caused by the fact that image signals as well as existing noise types are usually non-linear.

The median filter which is very popular in removing the salt and pepper noise from the images has undergone many changes in recent past. To this modified median filter the concept of median deviation is added and used in estimating and removing the noise. [3][2]

Decision based algorithm is proposed for restoration of images that are highly corrupted by impulse. noise. The decision based algorithm shows significantly better image quality than the Standard median filter, adaptive median filter and threshold

decomposition filter, cascade and recursive non-linear filters[1][4]. Decision based algorithm is effective for low noise densities i.e. up to 10%-20%. Also in decision based algorithm even though centre pixel is noise free, it is processed & replaced by new value which is median from selected window elements. Thus original pixel value is changed which may not be correct.

The proposed Decision based algorithm which gives accurate & efficient noise detection & filtering for impulse noise removal. The algorithm contains two stages: detection followed by filtering. In detection phase, centre element (pixel) is checked for error. In case of impulse noise faulty pixel value is '0' or '255'. Thus if centre pixel of selected window is '0' or '255' then it is treated as noisy and required to filter in next phase.

The proposed algorithm replaces the noisy pixel by clipping median value when other pixel values, 0'or 255's are present in the selected window and when all the pixel values are 0's or 255's then the noise pixel is replaced by mean value of all the elements present in the selected window.

V Literature survey

In paper [1] an efficient Decision Based algorithm is introduced for the restoration of images corrupted with almost all impulse noise levels. The filter is capable of producing recognizable, patches free outputs from images corrupted by higher levels of impulse noise. (March 2011)

In Paper [2] has proposed a novel approach for detecting median filtering in digital images, which can 1) accurately detect median filtering in arbitrary images, even reliably detect median filtering in low-resolution and JPEG compressed images; and 2) reliably detect tampering when part of a median-filtered image is inserted into a non-median- filtered image, or vice versa. The effectiveness of the proposed approach is exhaustively evaluated in five different image databases. (December 2011)

Paper [3] analyzed some filtering algorithms, & presented an efficient FPGA based solution for the image filtering.(2011)

Paper [4] has proposed Reconfigurable Hardware for Median Filtering for Image Processing Applications different architectures for implementation of image processing algorithm in hardware. It have been shown that such an implementation is cost effective and offers a low power implementation with FPGA chip the design is also supported VHDL compilers, libraries, etc.(march 2010)

In paper [5] author modifies the algorithm; however their implementation cost is higher. Best performance uses a window size of 7x7 pixels & can suppress noise up to 60%. (2008).

In research paper [6] proposed parallel-serial input scheme and algorithm. According to their algorithm first the number are sorted vertically then numbers are sorted horizontally and then in step 3 numbers are sorted cross diagonal elements and pick up the middle element this middle element is the median of the nine elements. They have ob-served that the hardware requirement of their design is very less. (Jan 1997).

VI. Implemented work

Decision based algorithm has played an important role in image preprocessing applications. In an N×N window, if the number of polluted pixels are greater than N(N+N)/2, then the noise won't be removed. In such case, increase the size of the window to improve the filtering efficiency. On the other hand, if the number of the pixels of edge features is smaller than N(N+N)/2, then the feature pixel will be replaced by other irrelevant pixels, and the features will be impaired. In such case, we have to reduce the size of the window to preserve image features. In order to strike a balance between noise removal and feature preservation, the size of the window has to be carefully chosen. Many of the signal processing solutions can be implemented in Field Programmable Gate Array (FPGA) instead of DSP chip. This is possible because the gate densities available on FPGA have increased rapidly within last few years and now allow fairly sophisticated DSP algorithm to be implemented within single chip. By considering previous papers survey, it is attempted to increase quality of image by providing an adaption in window size.

VII. Methodology

Proposed work focuses on implementation of decision based algorithm on the FPGA. Architecture is as shown in figure 1.Decision based Algorithm is used to remove the Impulse noise.

Level 1:- The proposed Decision Based algorithm processes the corrupted images by first detecting the impulse noise. The processing pixel is checked whether it is noisy or noisy free. If the processing pixel value lies between maximum and minimum gray level values then it is noise free pixel, it is left unchanged. If the processing pixel takes the maximum or minimum gray level then it is noisy pixel which is processed.

Level 2:- Noise Detection

Initially image pixels are stored at RAM locations.

Out of no of pixels only 9 pixels are forwarded to noise detection block through window selector which selects a window of 3 x 3(9 elements). By moving window over whole image, all image pixels are checked & processed if necessary.

Noise detection block check centre pixel. If it is noisy, then checks for two conditions. i) all pixels noisy ii) some pixels noisy

Level 3:- Noise filtering

If all the pixels are noisy then centre pixel is replaced by mean of the all pixel values.

If some of pixels are noisy then centre pixel is replaced by median value from selected window pixel values.

Derived value is now stored in another memory (RAM) at original position.

If centre pixel is noiseless then it is not necessary to filter & hence stored same value in RAM.

Complete process is monitored & controlled by Finite State Machine (FSM).

VIII .Implemented Block Diagram:

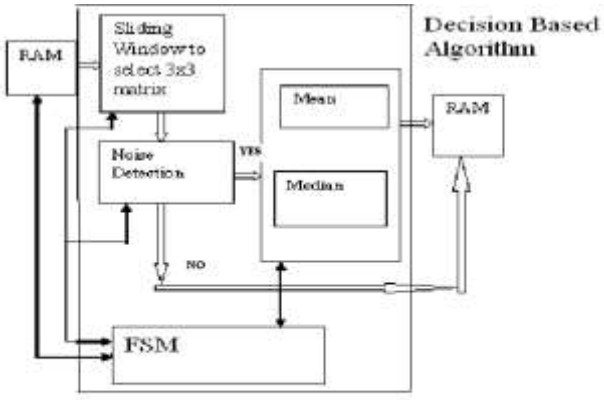

Figure.1 Architecture of proposed decision based algorithm

Figure 1 shows Architecture of proposed decision based algorithm .Decision based algorithm system is divided into three levels. 1st level checks processing pixel is noisy or noise free. 2nd level checks for two conditions. i) all pixels noisy, ii) some pixels noisy and in 3rd level noise filtering is done.

IX. Results of the Decision Based Algorithm

Noisy 128X128 Filtered

10% Noise

20% Noise

30% Noise

40% Noise

50% Noise

Noisy 256X256 *Filtered*

10% Noise

20% Noise

30% Noise

40%Noise

50% Noise

X. Conclusion

The performance of the decision based algorithm has been tested at low, medium and high noise densities on gray-scale images. Even at high noise density levels the algorithm gives better results in comparison with other existing algorithms. Both visual and quantitative results are demonstrated. The proposed algorithm is effective for salt and pepper noise removal in images at high noise densities.

XI. References

[1]K.S.Srinivasan and D. Ebenezer " A new and efficient Decision – Based Algorithm for Removal of High – Density Impulse Noises " IEEE Vol 14 No. 5
[2].Hai-Dong Yuan "Blind Forensics of Median Filtering in Digital Images" IEEE Transactions On Information Forensics And Security, Vol. 6, No. 4, December 2011
[3]Geoffrine Judith.M.C1 and N.Kumarasabapathy "STUDY AND ANALYSIS OF IMPULSE NOISE REDUCTION FILTERS " Signal & Image Processing : An International Journal(SIPIJ) Vol.2, No.1, March 2011
[4].Tripti Jain, Prashant Bansod, C. B. Singh Kushwah and Mayenk
Mewara "Reconfigurable Hardware for Median Filtering for Image Processing Applications " 2010 IEEE.
[5]. Marek Wnuk, "Remarks on hardware implementation of image processing algorithms," Int. J. Appl. Math. Computer. Sci., vol. 18, March 2008, pp.105-110, ISSN: 1641-876X.
[6].Rajul Maheshwari, S. S. S. P. Rao and P. G. Poonacha, "FPGA implementation of median filter," tenth International Conference on VLSI Design, Jan 1997, pp. 523-524.
[7] Ms. Rutuja N.Kulkarni1 , Prof. P.C.Bhaskar " Implementation of Decision Based Algorithm for Median Filter to extract Impulse Noise" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol. 2, Issue 6, June 2013

BIOGRAPHIES

Mr. Sanjay.P.Patil is PG student of ADCET,ASHTA and he his pursuing ME in Electronics and Telecommunication

Prof. V.A.Mane working as an assistant professor in annasaheb Dange college of Engineering and technology , Ashta