

Denoising of Impulse Noise Using Decision Tree Method and Contrasting Images

Saratha Preethi¹, Baby Sathya²

¹ PG Scholar, ² Assistant Professor

^{1,2} ME Embedded System Technologies, Anand Institute of higher Technology, Chennai, India

Abstract: Image processing plays several roles in which noise filtering and image enhancement are very important. Noise affects the pixels of the Image and affects the quality. Several types of noise are, mean while impulse noise is important one. Impulse noise is divided into two types: fixed and random valued impulse noise. Denoising the impulse noise using Decision Tree method is quite effective. The resultant image can be given out from an FPGA kit Spartan 3e. Contrasting has been done to improve the visualizing effect.

Keywords: Decision Tree, Impulse Noise, Noise Removal, Noise Filter, VLSI Architecture.

1. INTRODUCTION

Digital images play an important role both in daily life applications such as satellite television, magnetic resonance imaging, and biomedical instrumentation, remote sensing, computer aided design, etc. During image formation, acquisition, storage and transmission many types of distortions limit the quality of digital images.

Transmission errors, periodic or random motion of the camera system during exposure, electronic instability of the image signal, electromagnetic interferences, sensor malfunctions, optic imperfections or aging of the storage material, all disturb the image quality. In many practical situations, images are corrupted by the so called *impulsive noise* caused mainly either by faulty image sensors or due to transmission errors.

Furthermore, noise can be caused by fast transmission and compression. Impulse noise can be classified into two types: fixed-valued impulse noise and random-valued impulse noise. The fixed-valued impulse noise is also known as salt and pepper noise, image contain dark and white dots that is in the range of 0 and 255. The noisy pixel are corrupted by random-valued impulse noise are uniformly distributed in the range of [0,255].

2. DECISION TREE BASED DENOISE METHOD

A. System Architecture:

The system architecture as shown below in Fig 2, the noise detection algorithm is based on the concept of aggregated distances assigned to the pixels belonging to the filtering window. DTBDM consists of two components: decision-tree-based impulse detector and edge-preserving image filter. The decision-tree-based impulse detector is detector part which detects the noisy pixel in an image. If the result is positive, the corrupted image is given to the corrector part that is edge preserving filter which corrects the noisy pixel and the image will be enhanced then generates the reconstructed image.

The window size for the Denoising process is 3x3. Assume the pixel to be denoised is located at coordinate (i,j) and denotes as $p_{i,j}$. The mask under consideration is shown in Fig 1. Three modules are designed namely Isolation module (IM), Fringe module (FM) and Similarity module (SM). We have decided the pixels in the window as Top Half and Bottom Half. Three concatenating decisions of these modules make a decision tree. Then the corrupted image is given to the edge-preserving filter to generate reconstructed image.

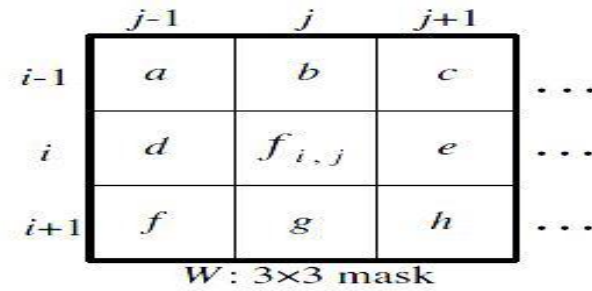


Fig 1. 3x3 window mask

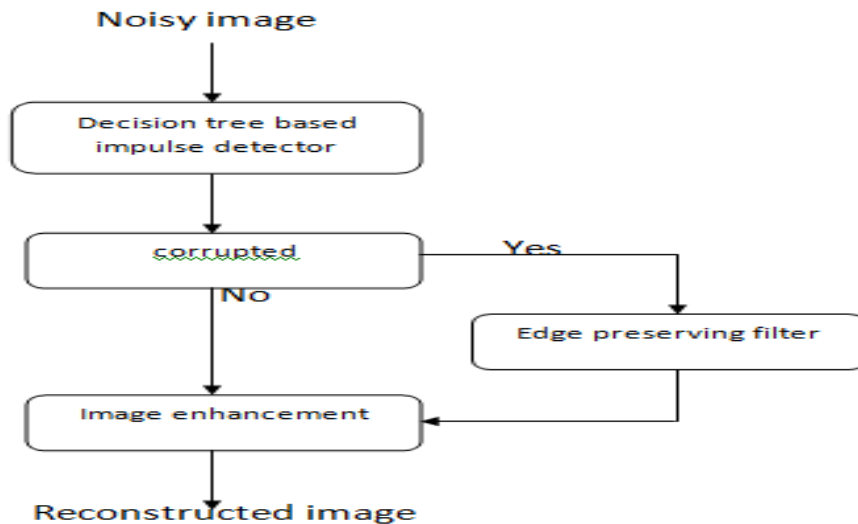


Fig 2. System architecture

I. ISOLATION MODULE:

Isolation module is to make a decision whether the pixel value is in a noisy area or noise-free area. Different components in Isolation Module is given in Fig 3. In order to avoid the complexity of the design, the 3x3 window is divided into two different regions. Window Top Half pixels are a,b,c,d and Window Bottom Half pixels are e,f,g,h.

In the given diagram shows the decision of isolation module for Top Half Difference (THD), like as decision for Bottom Half difference(BHD) will be taken. Top Half_Max, Top Half_Min, Bottom Half_Max, Bottom Half_Min values will be calculated by Comparator Large CMP_L and Comparator small CMP_S . Difference and absolute difference will be calculated using SUB and |SUB|, GC is the greater comparator respectively.

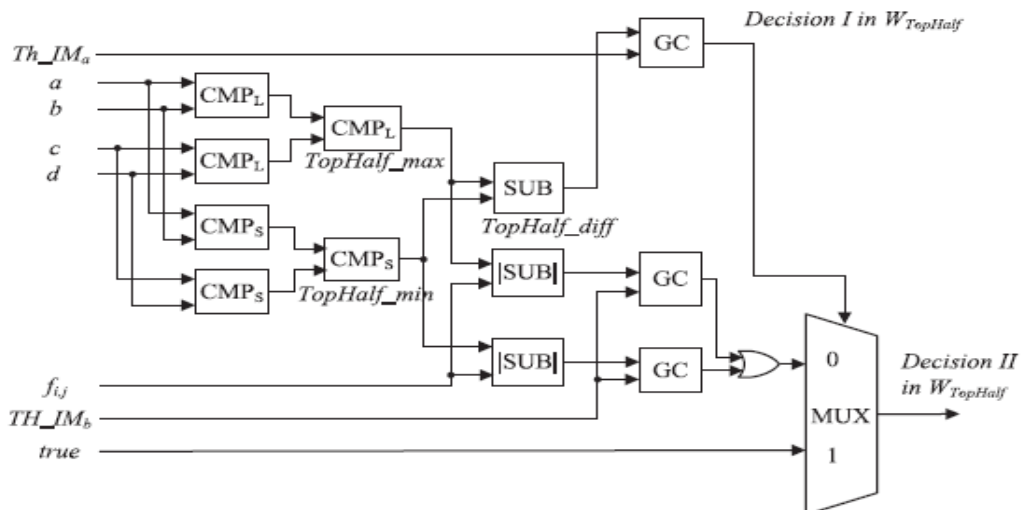


Fig: 3. Decisions of Isolation module

II. FRINGE MODULE:

If the pixel is situated in the edge the Fringe Module will detect whether it as noisy pixel or an edge pixel. Four directions are considered E1 to E4, then the fringe module can determine whether there is an edge or not. Below Fig 4 shows four directional windows to detect the edges. Fringe module takes the decision whether pixel is situated in edge or not. Fig 5 and 6 sows FM_1 to FM_4 determines corresponding pixel values of the four directions E1 to E4. If the result is positive then the corresponding pixel value is situated in edges otherwise it is noise.

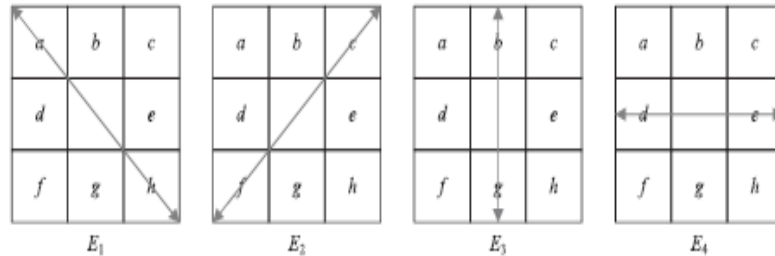


Fig 4. Directions of Fringe module

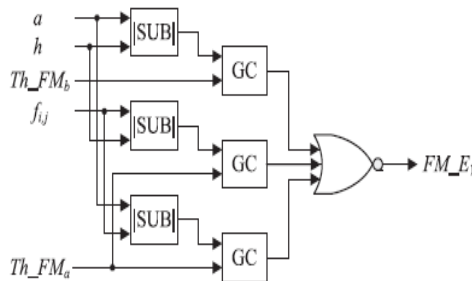


Fig 5. FM_1 module

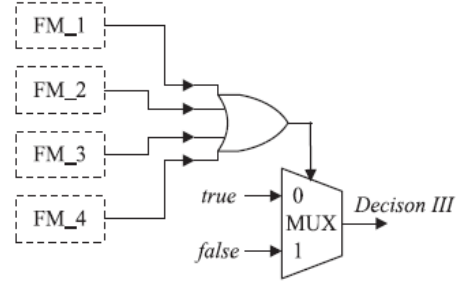


Fig 6. Decisions of Fringe module

III. SIMILARITY MODULE:

The last step in impulse detection is the Similarity Module. The median is always positioned in the center of the variation series, whereas the impulse is frequently located near one of its ends. Based on this nine values in ascending order are sorted and the 4th, 5th and 6th values are obtained which are close to the median in mask W, shown in fig 7, Similarity module will take the decision whether the pixel is noisy or not.

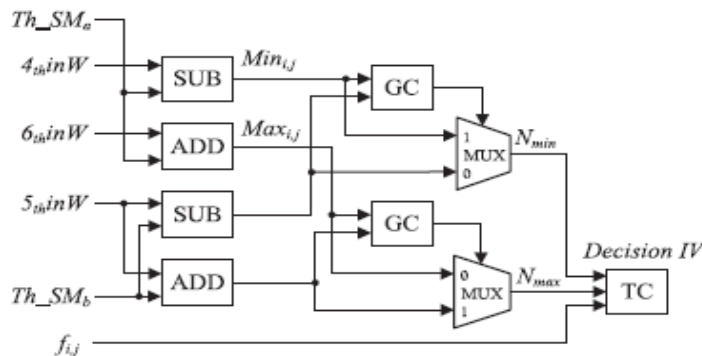


Fig: 7. Decisions of similarity module

IV. EDGE PRESERVING IMAGE FILTER:

Edge preserving is the corrector part, it will corrupt the noisy pixels and produce the Reconstructed image. Consider eight directional differences, D1-D8, for the reconstruction of the Noisy pixel in the image as shown in the Fig 9. The edge filter calculates the directional differences of the chosen directions and locates the smallest one (Dmin) among them shown in the Fig 8.

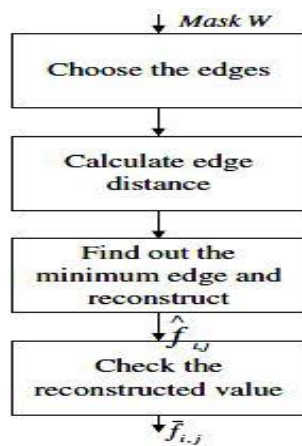


Fig 8. Edge detection architecture

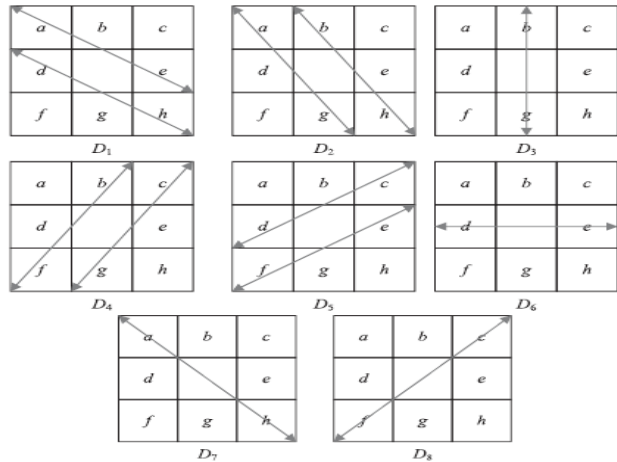


Fig 9. Directions of Edge detection

V. CONTRAST IMAGE:

An Image is enhanced using histogram equalization and to improve quality of image. After pixel of the image is out from edge filter is given to image enhancement part. Histogram equalization is applied to the image to improve the quality of the image.

3. RESULT AND DISCUSSION

The impulse detection process is a three stage process in the decision tree and is programmed in verilog HDL. Then simulated and verified using Modelsim Altera and Xilinx ISE, the pixel values is given to SPARTAN 3e FPGA kit. considered an image in Fig 10. In Fig. 11 noised added in the image. In the same way the Edge preserving filter reconstruct the value by considering the neighboring pixels is shown in Fig 12. If all the neighboring pixels are corrupted, then they will not be considered for the reconstruction of the pixel under consideration. Simulation and comparison Results are shown in Fig 13 and Fig 14.

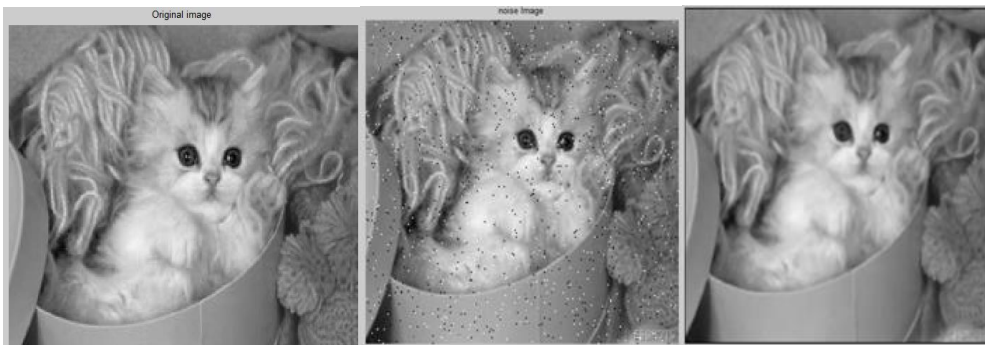


Fig 10. Original Image

Fig 11. 20% noise affected image and denoised image.

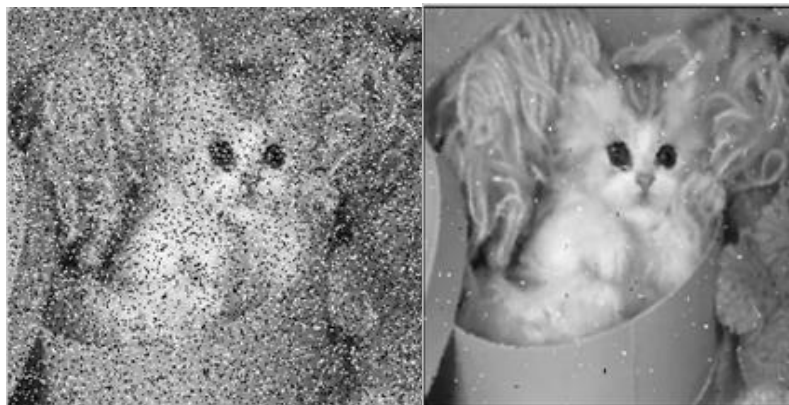


Fig 12. 60% noise affected image and denoised image.

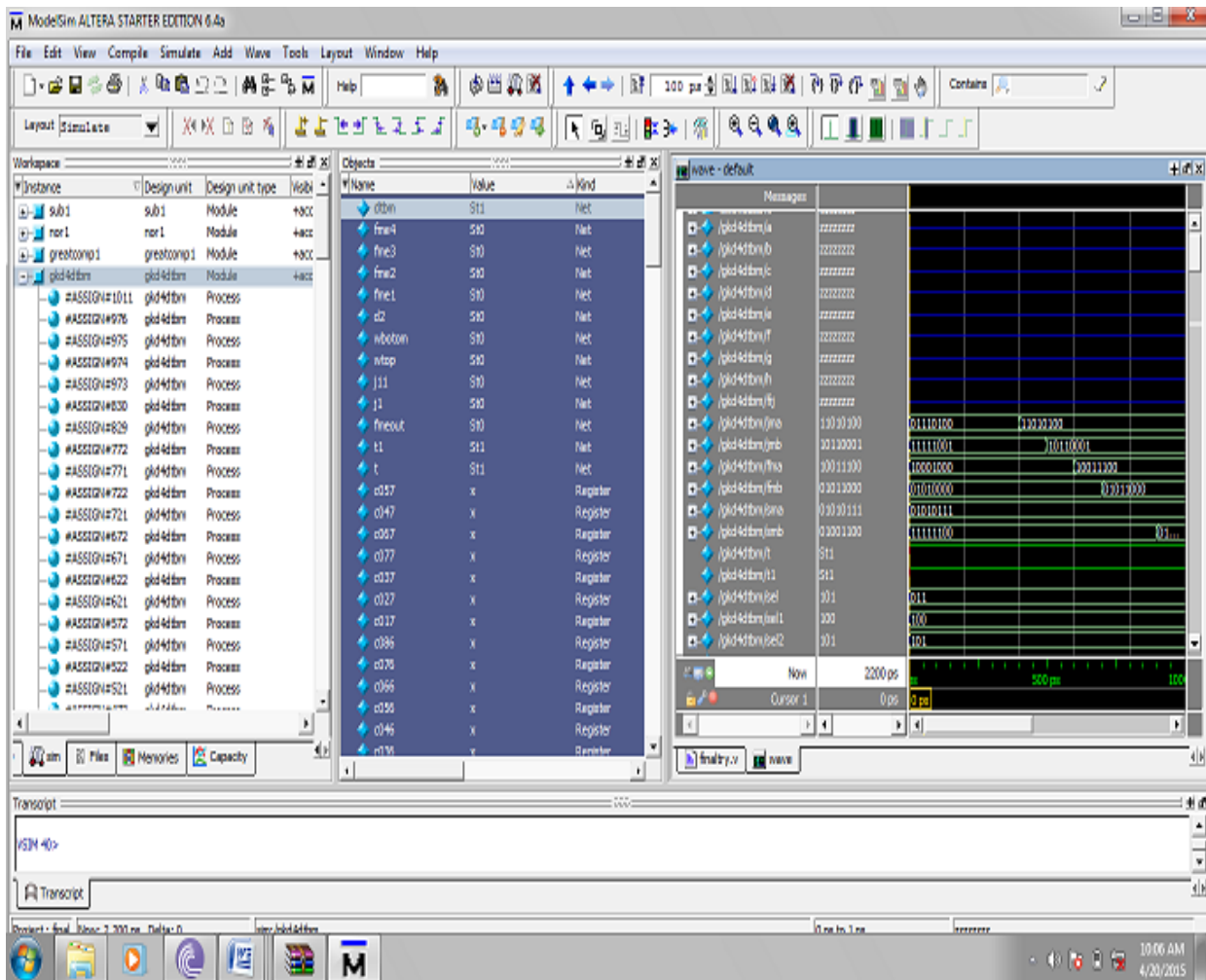


Fig13 .Simulation Result

B. Tables:

% of noise in images	PSNR	MSE
0.02	23.7073	276.9154
0.2	22.8437	337.8365
0.6	13.2032	3.1100e+03

Fig14 .comparison result of different percentage of salt & pepper noise

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5. CONCLUSION

The effective decision-tree-based Denoising methods detect the noisy pixel in image and eliminate corresponding noisy pixels. Edge preserving filter is used to regain edges in the image. With adaptive technology, the quality of the reconstructed images is improved. The experimental results determine that the performance of the proposed technique is better than the previous lower complexity methods in terms of both quantitative evaluation and visual quality. Therefore, it is very suitable to be applied to many real-time applications.

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