Review of Implementation of Fast buffering and filtering operations on FPGA

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***Abstract*: Noise removal from images forms an important aspect and widely researched area in recent times. Salt and pepper noise on images tends to degrade the quality of the image. Median filter is an important and simplest filter for the elimination of salt and pepper noise. Many new techniques have been evolved in recent years and implemented mostly on MATLAB environment. The implementation of these techniques and filters on FPGA requires buffering of image into the memory of the hardware so that windowing operations must be performed. In this paper a review of various techniques for buffering and filtering operation is presented and compared in terms of their timing complexity.**

***Keywords:* Median Filter, FPGA, Salt and Pepper Noise.**

I. INTRODUCTION

Digital images are affected by the noise formed from transmission of images, acquisition, scanner, camera sensor and Many more. Noise basically belongs to spurious intensity variations, which appears primarily due to insufficiency in imaging device recycled to achieve images or due to hindrance in communication channels used for communicating digital images [1]. Image denoising is the process to eliminate the noise from the images. Nonlinear filter such as adaptive mean filter are used for image denoising because they reduce the smoothing and preserve the image edges [2]. A typical general purpose Median filter is based on a sorting approach over the entire window elements to find the median value. Median filters work on the principle of replacing a given sample in a signal by the median of the signal values in a window around the sample [3].
While capturing image there is a chance of inclusion of noise, which will affect the pixel intensity values. There are a plenty sources of noise that affects the image. Some sources included transmission errors, imperfect instruments, natural phenomena, and imperfect data acquisition process and compression techniques. The image noise may not be visible but will be there in the image [4]. The image quality is affected by many factors such as environmental temperature, sensitivity of camera, time taken to capture images and so on. The brightness, color, smoothness in the image gets affected thus producing a picture which is undesirable. The following image is a noisy image with the presence of excessive random noise. [5]. Images get altered by various kinds of noise namely Salt and Pepper noise, Uniform noise, Gaussian noise, Rayleigh noise, Gamma noise and Exponential noise. Most frequently images get altered by two sorts of noise: the Impulse noise and Additive Gaussian noise however in case of digital data traffic, the main source of error is impulse noise as it is appears due to bit errors that appear during image transmission. Basically the aid of noise removal is to filter the impulses, which take either the maximum or the minimum value leading severe degradation of the aspects of image. The main motive of denoising is to get back the fine details of the actual picture as far as feasible while replacing the noisy pixels. [6]

The median filter algorithms optimize the sorting process to reduce the computational complexity. The median filter algorithms increase the quality of the filtered images without increasing the computational complexity of median filter algorithm. These algorithms try to detect the noisy pixels and adaptively filter only these noisy pixels. However, the adaptive median filter algorithm proposed in this paper both reduces the computational complexity of median filter algorithm and increases the quality of filtered images by exploiting the pixel correlations in the input image [10].

The organization of paper is as follows: in section II literature review is presented and section III concludes the paper

II. RELATED WORK

Verma, Kesari,et al. [1]in this paper, improvement in Adaptive Median Filter has been presented used for preservation of edges. In biomedical images

edges are the significant feature. The main motive of this paper is to preserve the edges without losing in signal to noise ratio (SNR) and peak signal to noise ratio (PSNR). In this work, Edge Retrieval Index (ERI) a new guideline for performance evaluation has also been proposed which helps to evaluate the edge safety index in images. In homogenous area, proposed approach cleans the entire image noise but preserves the edges. The results indicate that the proposed approach can be adapted to eliminate noise and prevent edges. The result also proves that, by using this approach edge lost is minimal.

Saleem, S. Abdulet al. [2] in this study, an Effective Noise Adaptive Median Filter have been proposed in order to eliminate Impulse Noises from Color Images. Color images are degraded by noise due to transmission, acquisition and storage. This proposed method helps to remove impulse noise and also maintained its image details. This method also helps to enhance its image quality. This novel method uses a spatial domain approach and 3×3 overlapping window to filter the signal. The proposed median filter has been assessed using MATLAB and simulations have been done on a both gray scale and color images. The results demonstrated the effectiveness of median filter when compared with some other adaptive mean algorithm.

Chakravarthy, SR Sannasi et al. [3] proposed a boundary discriminative noise detection algorithm for eliminating impulse noise and random noise. The features of Image will degraded by the impact of noise. In this work , modifications to the filtering step of the BDND algorithm has been presented by increasing the window size one step higher to existing size to solve those issues. The results indicate that proposed boundary discriminative noise detection algorithm can produce sharper image and also noise is removed. This proposed algorithm has been implemented using MATLAB 7.12 using image processing tool box.

KaurAmanpreet, Rahul Malhotra et al. [4] presented a non-iterative adaptive median filter. Here in this paper, noisy pixel is removed from given window using proposed method i.e. non-iterative median filter. The proposed approach has displayed effective performance, as it will eliminate the noisy pixel. Image processing toolbox has been used for the construction of the given median filters in MATLAB.

Habib, Muhammadet al. [5]an innovative technique using adaptive fuzzy inference system has been presented in this paper. This technique is used for detection and removal of random valued impulse noise. The presented filter uses the intensity which depends on directional statistics to build adaptive fuzzy membership functions. The Simulation results are depending upon quantitative measure especially, peak-signal-to-noise ratio (PSNR) display the effectiveness of suggested filter.

Bhateja, Vikrantet al. [6] proposed a non-iterative adaptive median filter used for removing images corrupted with impulse noise. This scheme works in two steps. In the first step the pixels are isolated as "noise-free" and "noisy" so as to process noisy pixels only. In the second step the analyzed noisy pixels are recovered by the median value. The suggested denoising approach is tested on images with distinct attributes and is establish to produce improved outcomes in terms of the quantitative and qualitative measures of the image in contrast to other filtering approaches.

Meher, Saroj Ket al. [7] in this paper, revised recursive and adaptive median filter has been presented. Proposed RAMF method used for the alteration of images corrupted with high frequency impulse noise. The size of window may change, depending upon the presence of noise free pixels. The outcomes show that the proposed way is so efficient as compared with other algorithm in term of image enhancement factor and peak signal to noise ratio (PSNR). The dominance of the proposed filter is also advocated qualitatively by visual analysis.

Shanmugavadivuet al [8] in this paper a newly designed noise filter that is, "Laplace Equation based Adaptive Median Filter" to denoise the images corrupted by fixed value impulse noise is presented. The performance of the suggested filter is proven to be superior in terms of Human visual perception and Peak Signal-to-Noise Ratio. This filter is confirmed to be efficient in denoising even the extremely corrupted images with the noise expectation of 90%.

Mukherjee, Manaliet al. [9] in this paper, a reconfigurable hardware architecture having low complexity has been presented for adaptive median filter and for the removal of impulse noise primarily salt and pepper noise from the digital images economical development of median & adaptive median filter is proposed. Performance analysis of peak signal-to-noise ratio (PSNR) and mean square error (MSE) is done to correlate these two filters. This paper proposes hardware implementation, which is extremely needed for real time execution. Field Programmable Gate Arrays (FPGAs) are extensively used for real time processing where the provision of speed, time, power, and area becomes stringent.

Kalali, Ercan, et al[10] presented a 2D adaptive median filter algorithm in this paper. In this work adaptive median filter reduces the complexity of 2D filters and it give good quality images. The novel method has been implemented for 5*5 window size. the proposed hardware can process 105 full HD (1920x1080) images per second in the worst case on a Xilinx Virtex 6 FPGA, and it has more than 80%

less energy consumption than original 2D median filter hardware on the same FPGA.

III. CONCLUSION

In this paper a review of various techniques used by digital designers is presented. The salt and pepper noise can be removed using various filtering operations implemented using FPGA and MATLAB. The results of PSNR (Peak Signal to Noise Ratio) are compared from both the operations. The FPGA implementation on FPGA also gives the area requirement and energy consumption by the unit. Few techniques reduce the energy consumption up to 80%. Few others prove the validity of their technique by denoising the images with the noise probability of 96%. The performance of the unit in terms of speed can be improved if the Buffering operation must be fast and efficient which depends on the size of window used in the implementation.

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