IJCSC International Journal of Computer Science and Communication Vol. 3, No. 1, January-June 2012, pp. 57-59

IMPLEMENTATION OF MODIFIED SELECTIVE MEDIAN FILTER IN FPGA – TOWARDS THE DETECTION OF BREAST CANCER

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ABSTRACT

In medical image processing, noise removal is the challenging task. Removal of noise using the existing methods like Median Filter (MF), Center Weighted Median Filter (CWMF), Rank Condition Rank Selection Filter (RCRSF) and SMF Selective Median Filter (SMF) provides satisfactory results. In this paper, we have made improvements in SMF by providing the adaptive thresholding concept and called as Modified Selective Median Filter (MSMF). Mean square error (MSE) and mean absolute error (MAE) has been calculated and the performance are compared. The performance of MSMF is better than the other methods and it is also implemented in field programmable gate array (FPGA). We found this method works good for the noise removal in mammograms for the detection of breast cancer. Furthermore, the method has been tested for the sample image mdb218 taken from mammographic image analysis society (MIAS) and the results found were good.

Keywords: Noise removal, filter, breast cancer, FPGA.

1. INTRODUCTION

In computer vision, segmentation refers to the process of partitioning a digital image into multiple segments [7, 8 and 9]. The goal of noise removal is to simplify the segmentation process. Several general-purpose algorithms and techniques have been developed for noise removal [1].

Since there is no perfect method to remove the noise and to enhance the image, it is proposed a new algorithm called modified selective median filtering. And it is especially used to enhance the digital mammogram image to detect microcalcifications. Calcifications are the indicators about the breast cancer. This noise removal filter has been implemented in FPGA.

2. MODIFIED SELECTIVE MEDIAN FILTERING

There are two possible approaches to enhance mammographic features. One is to increase the contrast of suspicious areas and the other is to remove background noise [2, 10 and 11]. The contrast of each region is calculated with respect to its individual background [6]. Removing background noise while preserving the edge information of suspicious areas can enhance the digital mammogram [4, 5]. This approach was investigated by Lai *et al.* [3], who used four selective averaging schemes and a modification of median filtering called selective median filtering. A selective median filter is, given a window $W(i, j)$, centered at image coordinates (i, j), the output of the selective median filter is given in (1).

$$X_{i,j} = \text{median} = \{X_{r,s}: (r, s) \in N(i, j), \text{ and } |X_{r,s} - X_{i,j}| < T\} \quad (1)$$

And where $X_{i,j}$ is the image intensity at (i, j), $N(i, j)$ is the area in the image covered by the window $W(i, j)$, and T is a threshold. In computing the median, the set of pixels is restricted to those with a difference in gray level not greater than some threshold T. Adjusting the parameter T can control the amount of edge smearing [12, 13, 14 and 15]. If T is small, the edge-preserving power of the filter is strong, but its smoothing effect is small. If T is large, the filter behaves the other way around and used to remove the background noise [1]. The adjustment of T in adaptive manor will provide best result. And this makes a new filter named modified selective median filter.

3. FPGA IMPLEMENTATION

This algorithm has been implemented in Xilinx 500K FPGA. It is a bit level running algorithm with modular and parallel in structure. Pixel levels of neighbor cells have been taken by the deletion and insertion process in an alternative manor [16, 17 and 18]. According to the proposed processing sequence, it is performed from the MSB to the LSB in parallelism and pipelined in the bit level with regular data flow for the deletion and insertion of bits.

It is in the bit level operation from the most significant bit (MSB) to the least significant bit (LSB). When the MSB of the deletion is completed, the MSB of the insertion is performed immediately. At the same time, the next coming window can be evaluated just after the order determination of the MSB of the current window. This makes the method reliable and good for FPGA implementation.

4. RESULTS

In Figure 1 the first image is the original mammogram image, the second image is the noise removed image using MSMF and the third is the noise removed image using MSMF after implemented in FPGA. Mean square error (MSE) and mean absolute error (MAE) has been determined and the results are tabulated in Table 1 and the power delay information is also given in Table 2.

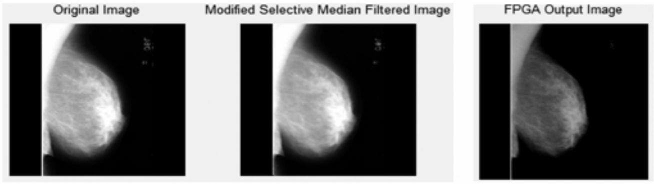

Figure 1: Results of the Mammogram Image (mdb218) Taken from MIAS Database.

Table 1
MSE and MAE Results of Noise Removal Methods

Methods	*MAE*	*MSE*	*Methods*	*MAE*	*MSE*
MF	3.41	41.50	SMF	0.67	13.63
CWMF	1.07	14.19	MSMF	0.45	11.91
RCRSF	1.03	26.91			

Table 2
Power and Delay Information of SMF and MSMF

Methods	*Power Dissipation*	*Delay Time*
SMF	18mW	1.72ns
MSMF	16mW	1.52ns

Table 1 shows the comparison between the proposed filter and the existing filters. The MAE and MSE of the proposed method is less and from Table 2 it is clear that the power dissipation and the delay are reduced in a much better way when compared to SMF.

5. CONCLUSION

Modified selective median filtering can correctly removes the noise and provides the original images in a clear form. The concept is simple and only needs the auto adjustment of thresholding. The result we found is good and satisfactory. In future, the time consumption of this algorithm has to be reduced. This work includes the FPGA implementation of this novel method with the high sample rate to support the real-time applications. Based on the evaluation result, it is concluded that the proposed bit level design can support the real time applications. The performance of this MSMF method obtains the smallest MSE (11.91) and MAE (0.45) with less power consumption (16mW) and less delay (1.52ns). Subjective evaluation also shows that the image quality has enhanced significantly.

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