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A new hybrid model to detect the mommogram images for early breast cancer

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ABSTRACT : Mammogram breast x-ray imaging is considered the most effective, low cost, and reliable method in early detection of breast cancer. In this paper a comparative analysis of Multi-stage Edge detection and fourth order Partial Differential Equations (PDEs) with median filter for cancer of mammograms image is done. Detection of edges in an image is a very important step towards understanding image features. Since edges often occur at image locations representing object boundaries, edge detection is extensively used in image segmentation when images are divided into areas corresponding to different objects. PDE-based methods can produce sharp edges without checkerboard effects; however, they are approximations and tend to weaken fine structures in the image. When a median filter is a non-linear digital filter which is able to preserve sharp signal changes and is very effective in removing impulse noise. The analysis is mainly done on the basis of structural similarity of image and peak signal to noise ratio (PSNR). The results of this study are quite promising.

Keywords : Breast Cancer, Mammograms, line edge detector, Fourth Order PDE, Median Filter.

I. INTRODUCTION

Breast cancer is a most dangerous type of cancer in women with highest incidence rates. In many countries, it is also the most common cause of cancer death in women and only exceeded by lung cancer in Asian countries and recently in the United States [1]. In United States, in 2004, the American Cancer Society estimates that, 215990 new cases of breast carcinoma have been diagnosed. Breast cancer is the leading cause of death because of cancer in women under the age of 65 [2]. Mammography screening programs have shown to be effective in decreasing breast cancer mortality through the detection and treatment of early onset of breast cancers.

Edge detection of Medical images is an important work for object recognition of the human organs such as lungs and breast, and it is an important pre-processing step in medical image segmentation [4-5]. In case of mammograms manifesting masses this corresponds to the detection of suspicious mass regions. For this purpose a number of image processing methods have been proposed. In this paper, we propose Line edge-based image extraction algorithm [6], a general-purpose method, which can quickly and effectively localize and extract breast cancer from mammogram images.

In the past few years, a large number of authors have proposed fourth order PDEs for edge detection and image denoising with the hope that fourth order PDEs method would perform better than their second order analogues [7]. Prior the formulation of non linear PDE based techniques, the complexity of noise reduction in image was treated through linear filtering in which the image intensity function is convolved with a Gaussian [8] . The main problem with this method is the blurring of image edges. Since the pioneering work of Perona and Malik [9] on anisotropic diffusion there has been a flurry of activity in PDE based denoising techniques. Albeit the method proposed by Perona and Malik and its variants are much better for denoising images, these methods tend to cause blocky effects in images.

The median filter is far from being a perfect filtering method as it removes fine details, sharp corners and thin lines [10]. The median filtering operation arrange the pixel values in a window in ascending order and picks up the middle value; the center pixel in the window is replaced by the middle value [11].

In this paper we focused on detection of mammogram image for breast cancer with the help of Multi-scale edge detector, Forth order PDE and median filter [6, 12, and 10]. The paper is characterized in following sections: Section II gives the Multi-scale edge detector and the fourth order PDE, Section III gives the proposed model, section IV gives experiment results and section V gives conclusions respectively.

II. THEORETICAL FOUNDATIONS

A. Edge detector

In line edge detector [3,6,13], we use magnitude of the second derivative of intensity as a measurement of edge strength which allows better detection of intensity peaks that normally characterize breast cancer mass in images . The region with a possibility of breast cancer mass in the mammogram image is detected .A Gaussian pyramid is created by successfully filtering the input image with a line edge detector mask. By considering the effectiveness and efficiency, convolved with directional filters at different orientation kernels for edge detection in the horizontal (0°), vertical (90°) and diagonal (45°, 135°) directions. The masks used are shown in Figure1.

–1	–1	–1
2	2	2
–1	–1	–1

0° Kernal

–1	–1	2
–1	2	–1
2	–1	–1

45° Kernal

–1	2	–1
–1	2	–1
–1	2	–1

90° Kernal

2	–1	–1
–1	2	–1
–1	–1	2

135°

Fig. 1 : (Line based edge masks)

In our proposed method, the acquires line edge detector images are concurrently processed by the masks operator as individual inputs. The regions having breast cancer mass in them will have significant higher values of average edge density, strength and variance of orientations than non-cancer mass regions. We exploit these three characteristics to generate a feature map which suppress the false regions and enhance true candidate text regions.

B. Fourth order PDE

One of the most commonly used PDE based denoising technique is introduced by the Perona-Malik method. The Perona - Malik equation for an image u is given by

$$\frac{\partial u}{\partial t} = \mathrm{div}[c(\nabla u)\,\nabla u],\; u(x, y) \,\%_{t=0} = u_0\,(x, y) \qquad ...(1)$$

where ∇u *is* the gradient of the image *u*, *div* is the divergence operator and *c* is the diffusion coefficient. The diffusion coefficient *c* is a non decreasing function and diffuses more on plateaus and less on edges and thus edges are preserved. Two such diffusion coefficients suggested by Perona and Malik [9] are

$$C(s) = 1D\;(1+(s/k)^2) \qquad …(2)$$

and $$C(s) = \exp\,[-(s/k)^2 \qquad …(3)$$

In our work we implemented and tested the fourth order PDEs proposed by *You* and *Kaveh* which is discussed below. *You* and *Kaveh* [14] proposed an *L2 – curvature* gradient flow method as

$$= \nabla^2\,[c\,(\nabla^2 u)\,\nabla^2 u] \qquad …(4)$$

Where $\nabla^2 u$ is the Laplacian of the image *u*.The discrete form of non-linear fourth order PDE described in (4) is as follows :

$$u^{n+1}_{i,j} = u^{n}_{i,j} \;\text{”t Ñ}^2\, g^{n}_{i,j} \qquad …(5)$$

III. PROPOSED MODEL

The basic steps of the model are given below

1. Develop a Gaussian pyramid by convolving the input image (u) with a line edge masks.
2. Develop the directional masks to detect edges at 0^0, 45^0, 90^0 and 135^0 orientations (Figure-1).
3. Convolve each image in the Gaussian pyramid with each orientation filter.
4. Conjugate the results of step 3 to create the Feature Map (Figure 2e, 3e).
5. Numerate the Laplacian of the image intensity function as:

$$\nabla^2 u^n_{i,j} = u^n_{i+1,j} + u^n_{i\,1,j} + u^n_{i,j+1} + u^n_{i,j\,1} \bullet 4\,u^n_{i,j} \qquad …(6)$$

6. Numerate the value of the following function:

$$g(\nabla^2 u) = f\bullet(\bullet\nabla^2 u\bullet)\,[\nabla^2 u\; D\,(\bullet\nabla^2 u\bullet)]$$
$$= c(\bullet\nabla^2 u\bullet)\,\nabla^2 u \qquad ...(7)$$

As $$g^n_{i,j} = g\,(\nabla^2 u^n_{i,j}) \qquad ...(8)$$

7. Numerate the Lapcaian of, $g^n_{i,j}$

$$\nabla^2 g^n_{i,j} = g^n_{i+1,j} + g^n_{i\,1,j} + g^n_{i,j+1} + g^n_{i,j\,1} \bullet 4\,g^n_{i,j} \qquad ...(9)$$

8. Numerate the : $u^{n+1}_{i,j}$

$$u^{n+1}_{i,j} = u^n_{i,j} \bullet\bullet\, t\,\nabla^2 g^n_{i,j} \qquad …(10)$$

9. Filtering with median filter (Figure 2f, 3f)

$$u^{n+1}_{i,j} = M_{\alpha\omega}(u^n_{i,j} \bullet\bullet\, t\,\nabla^2 g^n_{i,j}) \qquad …(11)$$

Where *M* is the median filter with lower bound α and upper bound ω.

IV. EXPERIMENT RESULT

The proposed model was implemented using MATLAB. Figures (2a, 3a) show the original mammogram images, Figure (2b, c, d, e, f) and Figure (3b, c, d, e, f) show the proposed model images. The proposed model was implemented using two breast cancer mammogram images. Fig. 2(f) and 3(f) shows good results for almost all test images, that is the cancer parts on all mammography images can be seen more clearly in the enhanced images than in their original ones. Table 1 contains the experimental results, which can be achieved using the proposed model.

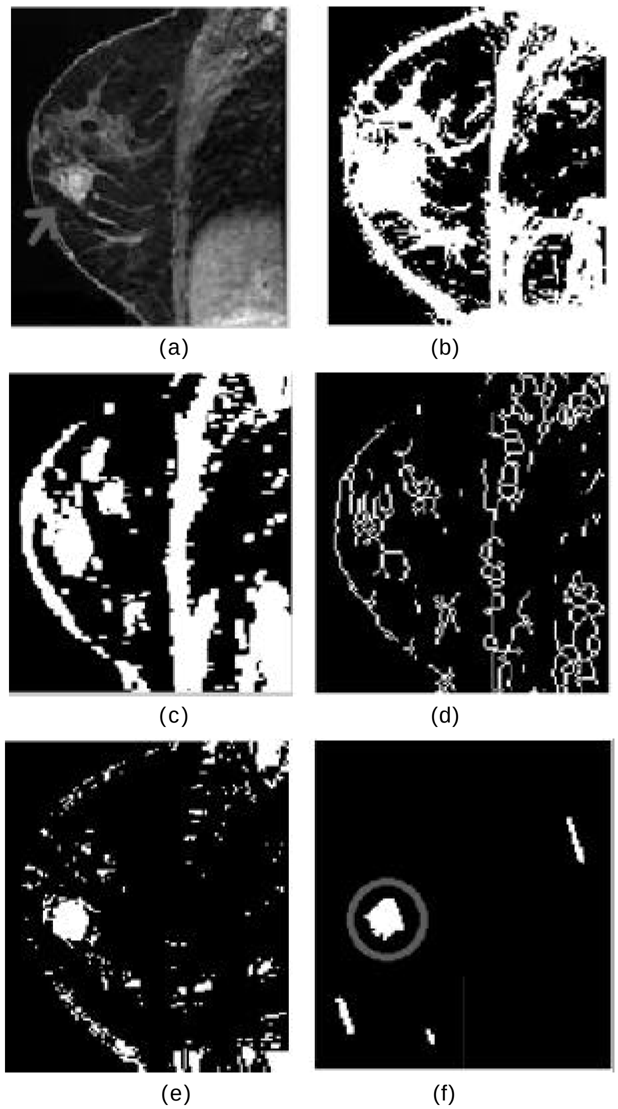

Fig. 2 : Mammogram image 1. (a) Original Image (b) line edge Detection image in all direction (c) Dilated mammogram image (d) Thinned Image (e). Feature map Image (f) Final result (Fourth order PDE and median filtering process).

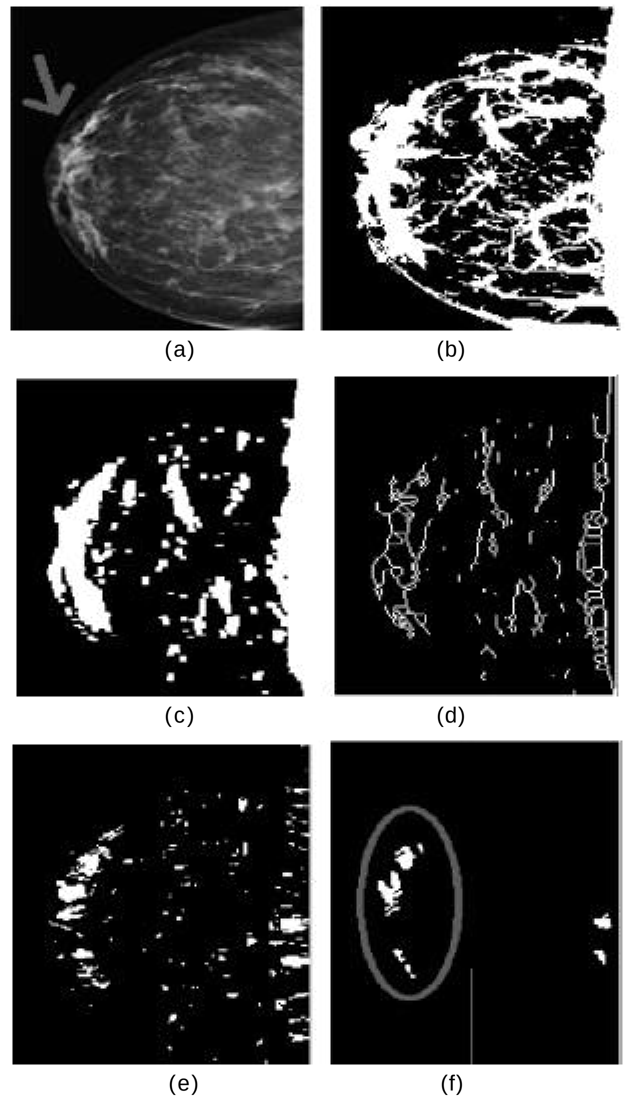

Fig. 3 : Mammogram image 2. (a) Original Image (b) line edge Detection image in all direction (c) Dilated mammogram image (d) Thinned Image (e). Feature map Image (f) Final result (Fourth order PDE and median filtering process

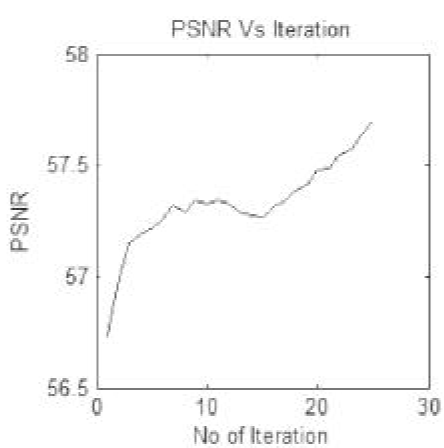

Fig. 4 : PSNR vs Iteration of Mammogram image 2

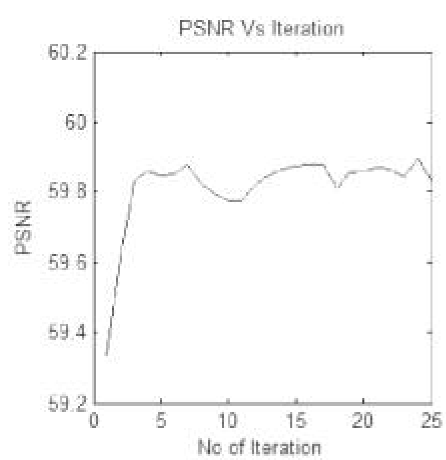

Fig. 5 : PSNR vs Iteration of Mammogram image 2

Table 1: Experiment result

Experiment Stage	Mammogram image 1 (PSNR in db)	Mammogram image 2 (PSNR in db)
Original Image	24.939	27.788
Line edge Detection image in all direction	43.299	47.669
Dilated mammogram image	46.902	51.174
Thinned Image	52.221	56.729
Feature map Image	52.669	58.126
Fourth order PDE and median filtering process	57.1745	59.831

V. CONCLUSION

A new hybrid model for mammogram images for early breast cancer detection was proposed. Breast cancer is one of the major causes of death among women. So early diagnosis through regular screening and timely treatment has been shown to prevent cancer. In this paper we have presented a novel approach to identify the presence of breast cancer mass in mammograms.

The line based edge detector and Fourth PDE with median filter is a new approach, using this we have successfully detected the breast cancer masses in mammograms. The result indicates that this system can facilitate the doctor to detect breast cancer in the early stage of diagnosis process. To be more specific it is observed that for Table-1, proposed model gives better PSNR than line based edge detector. The peak signal to noise ratio factor of the proposed model was computed and it is practically accepted.

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