Fusion of Noise and Contrast Enhancement Filters for Efficient Ovarian Cancer RoI Localization

Suthamerthi Elavarasu, Viji Vinod

ABSTRACT--- The emerging trend of artificial intelligence sets new research goal for Computer-Aided Diagnosis (CAD) to provide precise ovarian cancer region to overcome the observational oversights of the radiologists. The CAD system allows automated detection and classification of ovarian cancer affecting region during real-time radiology scanning and potentially helping radiologists to avoid false negative observation of ovarian cancer and facilitate subsequent clinical management of patients to avoid critical conditions. However, the media images are usually subject of affect by Gaussian noise, speckle noise, etc. and contrast variations due to human skin conditions, and so on. So getting good quality medical images from scanning system extremely important task for CAD further process. This paper proposes the fusion of noise and contrast enhancement filter for ovarian cancer medical image quality enhancement for CAD. The proposed approach uses the wiener filter for noise removal and contrast limited adaptive histogram equalization (CLAHE) for contrast enhancement. This proposed approach enhances the ovarian cancer medical images quality and facilitates to localize the region of interest (RoI) of ovarian cancer regions. The proposed method is simulated with real ovarian cancer patient medical images on MATLAB and performance of these filters are compared with image quality parameter Peak Signal-to-Noise Ratio (PSNR).

Keywords— Ovarian Cancer, Noise Filter, Contrast Enhancement Filter, Wiener Filter, Contrast Limited Adaptive Histogram Equalization (CLAHE), Computer Aided Diagnosis (CAD), Machine Learning, Artificial Intelligent (AI)

I. INTRODUCTION

Recent days, Computer-Aided Diagnosis (CAD) methodologies employed in clinical practices for medical images acquired from CT scan, MRI, X-Rays, and computed radiography using advanced imaging camera system and optical technologies to aid radiologists in detecting potential abnormalities on radiology diagnostic medical tests. The medical image capturing techniques are suffers from poor contrast and noise and issues.

The use of machine learning and artificial intelligent (AI) in healthcare diagnosis motivates the CAD to reduce the observational oversights by precise detection of disease by reducing the false negative rate. This is only possible when we get the high quality medical images from medical imaging system. This goal of this paper is to focus on how to get noise free and contrast enhanced medical images for CAD to predict ovarian cancer.

The noise reduction and removing process in medical image is an important research aspect for modern CAD. There are many denoising and image enhancement techniques are applied on medical imaging based systems [1-4]. The quality enhancement of the medical image for CAD is still a challenging issues for researchers because noise removal introduces blurriness and artifacts on the medical images. In this paper, we considered both noise and contrast enhancement filters to improving the quality of the medical images. This paper proposes the fusion of wiener and CLAHE filter to enhance the ovarian cancer medical image suffers from poor contrast and noise and issues.

The rest of the paper is structured as follows: In Section II, we discuss the various denoising techniques for medical imaging system. The proposed fusion of noise and contrast enhancement filters for ovarian cancer RoI localization is discussed in Section III. Section IV deals with the simulation and result analysis of proposed algorithm to effectively detect ovarian cancer RoI. Finally, we conclude the research in Section V.

II. MEDICAL IMAGE COMPUTING TECHNIQUES FOR DENOISING

The medical images captured from CT scan, MRI, X-Rays, and computed radiography usually are prone to Gaussian noise and salt and pepper noise which has influence on the medical image quality [5, 6]. The poor quality of medical image tends to degrade the performances of CAD. The preprocessing in medical image has been used with contrast enhancement, segmentation, decomposition, pectoral muscle detection and suppression, etc. The medical image preprocessing employs filtering techniques to enhance the medical images for CAD and that involved various tasks like noise reduction or denoising, re-sampling, and interpolation.

The preprocessing of mammogram medical images is used to reduce noise, edge-shadowing effect, detection of pectoral muscle, and suppression of the pectoral muscle successfully without losing any patient disease specific information from the image. The resultant mammogram image used for the automated abnormalities detection, asymmetry analysis, etc. [11].

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The medical image denoising can be used up in various domains filtering like spatial, frequency and wavelet domain techniques. There are lot of denoising techniques are developed for medical imaging system and each techniques having its own advantages and denoising limitation. The researchers needs to considered the factors like amount of noise present in the medical images, performance in denoising, and computational cost to remove noise efficiently [7, 8].

The adaptive filters changes the behavior of filter based on the statistical characteristics of the medical images inside the defined window filter region, which is defined by the maximum or mean or median value of the defined windows region. The adaptive filter performance in denoising is superior to non-adaptive filters and the mean and variance are important mathematics measures used in adaptive filters design [9].

In recent times, there are variety of non-linear filters like min filter, median filter, max filter, adaptive median filter, have been developed to overcome the linear filters noise removal limitation linear filter [10]. The median filter works effectively to remove the impulsive noise present in the MRI medical images efficient [12]. This paper focus on the denoising techniques based on the type of noise and amount of noise present in the ovarian cancer medical image.

III. FUSION OF NOISE AND CONTRAST ENHANCEMENT FILTERS FOR OVARIAN CANCER ROI LOCALIZATION

Medical Imaging in CAD is playing the major role in diagnosing and treatment of diseases such as locating the cancer, tumors, fractures in bones, etc. The image denoising is important pre-processing step in medical image analysis to make accurate decisions the medical images acquired by various medical imaging system must be free from noise. Its difficult task to develop denoising algorithms for medical imaging systems because need to preserve the medical diagnostic information while removing the noise from images.

Most commonly used medical image denoising algorithms are introduce the blur in the denoised images while removing noises in the medical images. In this paper, we are proposing the fusion method which uses the denoising procedures and contrast enhancement procedure to over limitation of the spatial and frequency based denoising methods on ovarian cancer medical images (shown in Fig.1).

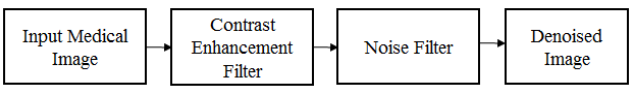


Fig. 1. Proposed Fusion Method for Medical Image Denoising

The Contrast Limited Adaptive Histogram Equalization (CLAHE) filter is proposed to use in this paper to improve image contrast for ovarian cancer medical images to overcome the amplification of lighting noise problem and to improve the image contrast. Adaptive Wiener Filter (AWF) is considering frequency domain filter.

The ovarian cancer medical images prone to common noises like Gaussian noise and salt and pepper noise at the time of capture and Gaussian noises and impulse noises are used to be distributed at the time of medical image transmission. The Wiener filter is proposed to use in this paper to remove common noises added in medical images at time image acquisition and transmission. The Wiener filter uses a pixel-wise a statistical estimation from a local neighborhood of each pixel in the defined window size MxN. The mean and variance are two important statistical measures used to design the Wiener filters on the neighborhoods of M-by-N window size.

Fig.2 describes the proposed CLAHE and Wiener fusion method block diagram.

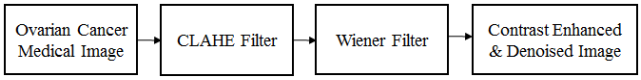


Fig. 2. Fusion of CLAHE and Wiener Filter for Ovarian Cancer Medical Image Denoising

The proposed CLAHE and Wiener fusion method provides high efficiency on the ovarian cancer medical image enhancement and the performance of this proposed fusion algorithm is evaluated using peak signal to noise ratio (PSNR) quantitative analysis. The quantitative PSNR analysis defined as in equation (1):

$$\text{PSNR} = 20 \log_{10}\left(\frac{MAX}{\sqrt{MSE}}\right) \quad \text{---------- (1)}$$

Here, 'MAX' is the maximum pixel value of the ovarian cancer medical image and 'MSE, is mean squared error (MSE) used as defined as in equation (2):

$$\text{MSE} = \sum_{i=0}^{h-1} \sum_{j=0}^{w-1} [I(i,j) - E(i,j)]^2 \quad \text{---------- (2)}$$

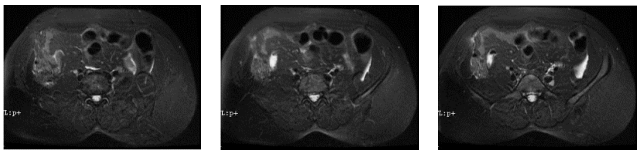
Here, 'w' is with and 'h' is height of the input (I) and enhance (E) medical image used in the proposed system evaluation.

IV. SIMULATION AND RESULTS ANALYSIS

Preprocessing is the first step in the CAD system. The proposed CLAHE and Wiener fusion method to remover noise on ovarian cancer medical image is simulated using MATLAB and the performance evaluated with most used common noise filters: Median and Wavelet filter.

In this simulation, the ovarian cancer test medical image first processed in the CLAHE and then applied the wiener filter to remove the common noises. CLAHE does not considers the input image in whole but separates it as tiles and enhances the contrast of each tile thereby enhancing the contrast of the entire image.

In this simulation, the MATLAB based proposed medical image computing methods preprocesses the real-time ovarian cancer patient medical samples (three samples shown in Fig 3) collected from medical centre for analysis.



a. Sample 1 b. Sample 2 c. Sample 3

Fig. 3. Ovarian Cancer Medical Image Samples

The change in the ovarian cancer medical image after the proposed preprocessing techniques is a reduction of noise and an enhancement of contrast. The resultant denoised ovarian cancer medical images is shown in Fig.4.

a. Sample 1 b. Sample 2 c. Sample 3

Fig. 4. Resultant Denoised Ovarian Cancer Medical Image

Table 1 shows that the proposed fusion of CLAHE with wiener filter has the highest PSNR values when compared with most common used medical imaging preprocessing methods like median and wavelet filters.

Table 1: PSNR Value with different Filters

S.No	Filter Method	PSNR Value
1	CLAHE with Median Filter	20.13
2	CLAHE with Wavelet Filter	19.72
3	CLAHE with Weiner Filter	25.43

In this simulation result, we observed that fusion of CLAHE with Weiner filters provides higher efficiency for the ovarian cancer medical image enhancement. The resultant enhance ovarian cancer image improves the ovarian cancer region localization efficiency as well as reduce the observational oversights by improvement of the false negative rate on the ovarian cancer detection in CAD system.

V. CONCLUSION

This paper presents the novel approach for ovarian cancer medical image denoising using fusion of CLACHE and Weiner filter to use in CAD system. The observation in the result shows that the proposed method methods work efficiently to remove noise on ovarian cancer medical images compared with tradition methods like median filter wavelet filter.

The CLACH is a spatial domain methods uses the pixel level minima, maxima and average value through entropy analysis to adjust the contrast level in the ovarian cancer image. The Weiner filter removes the common noise distributed at that time of capture and transmission using statistical parameters mean and standardization. The results are evaluated in MATLAB simulation for uniquely different real ovarian patients scanned medical images. This enhancement on ovarian cancer images facilitates to localize the precise region of ovarian cancer and improves ovarian cancer detection false negative rate. The radiologist can reduces the observation oversights by improving this detection false negative rate.

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