MAMMOGRAM IMAGE ENHANCEMENT BY USING A TWO-STAGE DENOISING FILTER AND CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION

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To my beloved parents, wife and family

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ABSTRACT

Digital mammography proved its efficacy in the diagnosis of breast cancer as an adequate and easy tool in detection tumors in their early stages. Mammograms have useful information on cancer symptoms such as micro calcifications and masses, which are difficult to identify because mammograms images suffer from some defects such as high noise, low-contrast, blur and fuzzy. In addition, mammography has major problem due to high breast density that obscures the mammographic image leading to more difficulty in differentiating between normal dense tissue and cancerous tissue. Therefore, for accurate identification and early diagnosis of breast cancer, mammograms images must be enhanced. Image enhancement commonly focuses on enhancing image details and removing noises. Using image processing techniques for mammogram images help to differentiate a special data that contain specific features of the tumors, which could be helpful in classifying benign and malignant tumors. This research focuses on salt and pepper noise remove and image enhancement to increase the mammography quality and improve early breast cancer detection. To achieve this purpose, a special technique is used that includes two stages image denoising base filtering and one stage for contrast enhancement. The filtering stages include the using of median and wiener filters. The contrast enhancement stage uses contrast limited adaptive histogram equalization (CLAHE). The evaluation of the performance is measured by PSNF and MSE for the filters and by contrast histogram for the CLAHE. The results show better performance of the research technique compared with other methods in terms of high PSNR(47.4750) and low MSE(1.1630). For future work, the technique will be evaluated with other type of noise.

ABSTRAK

Mamografi digital terbukti keberkesanannya dalam diagnosis kanser payudara sebagai alat yang mencukupi dan mudah di dalam tumor pengesanan di peringkat awal mereka. Mamogram mempunyai maklumat berguna mengenai gejala kanser seperti mikro klasifikasi dan jisim, yang sukar untuk dikenal pasti kerana imej mamogram mengalami beberapa kecacatan seperti gangguan yang tinggi, kontra yang rendah, kabur dan jelas. Tambahan pula, mamografi mempunyai masalah besar kerana kepadatan payudara yang tinggi mengaburkan imej mammographic menyebabkan lebih sukar dalam membezakan antara tisu padat biasa dan tisu kanser. Oleh itu, untuk mengenal pasti yang lebih tepat dan diagnosis awal kanser payudara maka imej mamogram mesti dipertingkatkan. Pemulihan imej biasanya memberi tumpuan kepada meningkatkan butiran imej dan menyahkan gangguan. Menggunakan teknik pemprosesan imej untuk imej mamogram membantu untuk membezakan data khas yang mengandungi ciri-ciri tertentu tumor yang tertentu, yang boleh membantu dalam mengklasifikasikan tumor benigna dan malignan. Kajian ini memberi tumpuan kepada penyahkan garam dan gangguan lada dan peningkatan imej untuk meningkatkan kualiti mamografi dan meningkatkan pengesanan awal kanser payudara. Untuk mencapai tujuan ini, satu teknik khas digunakan yang merangkumi dua peringkat imej asas iaitu denoising penapisan dan satu pentas untuk peningkatan kontras. Peringkat penapisan termasuk penggunaan median dan penapis wiener. Peringkat peningkatan menggunakan kontras terhad penyesuaian histogram penyamaan (CLAHE) adalah terbaik berbanding penilaian prestasi diukur dengan PSNF dan MSE untuk penapis dan histogram bagi CLAHE . Keputusan menunjukkan prestasi yang lebih baik bagi teknik penyelidikan berbanding dengan kaedah yang lain dari segi PSNR(47.4750) .tinggi dan rendah MSE(1.1630). Pada masa depan , teknik yang digunakan akan dinilai dengan lain-lain jenis gangguan.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Researchers around the world are making continuous efforts for early detection of breast cancer as a successful way to identify the disease and eliminate its effects. Radiographic examination is one of the means of early detection of this disease. By this mean, images for the breast are taking by x-ray, which is able to detect small changes and delicate tissue that may indicate the presence of a malignant disease. The computer has helped greatly in supporting and developing means of screening and diagnosing this disease.

1.2 Breast Cancer

Breast cancer is one of the most dangerous types of cancer among women all over the world. It happens to over 11% women during their lifetime. The World Health Organization named International Agency for Research on Cancer (IARC) estimates that more than one million cases of breast cancer will occur worldwide annually and more than 400,000 women die each year from this disease. Early detection of breast cancer is essential in reducing life fatalities.

However, achieving this early detection of cancer is not an easy task. Although the most accurate detection method in the medical environment is biopsy, it is an aggressive invasive procedure that involves some risks, patient discomfort and high cost (Eltoukhy et al, 2009).

1.3 Detect Breast Cancer

There are many techniques for detect breast lesions, like ultrasonography and magnetic resonance imaging. But mammography has proven to be the most effective tool for detecting breast cancer in its earliest and most treatable stage, so it continues to be the primary imaging modality for breast cancer screening and diagnosis (Dos Santos Teixeira 2012; Urbana Ivy et al., 2012).

A mammogram is an x-ray exam of the breast that's used to detect and evaluate breast changes. X-rays were first used to examine breast tissue nearly a century ago, but modern mammography has only existed since the late 1960s, when special x-ray machines were designed and used just for breast imaging. Since then, the technology has advanced a lot, and today's mammogram is very different even from those of the 1980s and 1990s (American cancer society).

Mammography has major problems due to high breast density which obscures the mammographic image. A woman's breasts are naturally denser, or more glandular when young, which makes it difficult for the radiologist to analyze the mammogram image. Technology to detect breast cancer is changing rapidly, with recent entrants to the field like digital mammography and computer aided detection. Enhancing the image by manipulation of fine differences in intensity by means of image processing algorithms forms the basis of any computer aided detection system (Eltoukhy et al., 2009).

1.4 Computer Aided Mammography

The mammograms interpretation is a visual task and is subject to human error. Computer-aided image interpretation has been proposed to help radiologists to perform this difficult task. Research into the use of computers to detect breast cancer in mammograms has been underway for many years. In the most common approach, a computer automatically analyses a digitized mammogram and attempts to locate signs of cancer. Detections are displayed to clinicians as prompts on a computer screen or paper printout (Rose, 2005).

Digital mammography has been used in attempts to reduce the negative biopsy ratio and the cost to society by improving feature analysis and refining criteria for recommendation for biopsy. Digital mammography is a convenient and easy tool in classifying tumors, and many applications in the literature proved its effectiveness in breast cancer diagnosis. Image features extraction is an important step in image processing. The features of digital images can be extracted directly from the spatial data or from a different space. Using a different space by a transform such as Fourier transform, wavelet transform or curvelet transform can be helpful to separate a special data. Detecting the features of image texture is a difficult process since these features are mostly variable and scale-dependent (Eltoukhy et al., 2009).

1.5 Problem Background

Quantum noise prevails in situations where an image is created by the accumulation of photons over a detector. Typical examples are found in standard x-ray films, CCD cameras, mammograms, and infrared photometers (Naseem et al., 2012).

X-ray mammography is the most common technique used by radiologists in the screening and diagnosis of breast cancer (Mencattini et al., 2008). But, the quality

of the breast mammogram images may suffer from poor resolution or low contrast because of the limitations of the X-ray hardware systems in mammogram machines (Naseem et al., 2012). Although it is seen as the most reliable method for early detection of breast carcinomas, reducing mortality rates by up to 25%, its interpretation is very difficult where 10%–30% of breast lesions are missed during routine screening (Mencattini et al., 2008).

X-ray mammography suffers from many problems. The main predominant and more likely problem to occur in mammogram images is quantum noise due to electrical fluctuation (Naveed et al., 2011). Quantum noise occurs in the mammogram images during acquisition due to low count X-ray photons. It affects the quality of images. It also affects the classification accuracy to classify images into benign and malignant (Naseem et al., 2012).

Also, Mammography has major problem due to high breast density that obscures the mammographic image leading to increase the differentiating difficulty between normal dense tissue and cancerous tissue when looking for small tumors surrounded by glandular tissues. To increase the diagnostic performance of radiologists, several computer-aided diagnosis schemes have been developed to improve the detection of either of the two primary signatures of this disease named masses and micro-calcifications.

Mass enhancement introduces much more difficult problems with respect to micro-calcifications. In fact, because of low contrast, they appear embedded in and camouflaged by varying densities of parenchymal tissue structures. Thus, it is very difficult to visually detect them on mammograms (Mencattini et al., 2008).

Radiologists mainly estimate breast density by visual judgment of the imaged breast. Thus automatic tissue classification methods try to imitate such visual judgment, learning from the radiologist experience. In the literature different approaches for classifying breast tissue based only on the use of histogram

information have been proposed (Zhou et al., 2001). Radiographic density is a scheme or measure aiming to explain or find a correlation between density and cancer risk, but the technique lacked objectivity due to intra and inter observer variations.

Recently, researchers have used many techniques to analyze radiographic density in digital images, and used many techniques to classify breast density pattern. When mammograms are analyzed by computer, the pectoral muscle should preferably be excluded from processing intended for the breast tissue. In the literature different approaches for automatic pectoral muscle segmentation have been proposed. Segmentation of the breast and the pectoral muscle are often prerequisites for automatic assessment of breast density (Kwok et al., 2004).

However, in many of the approaches used, the entire breast including the pectoral muscle has been proposed to extract features. The inclusion of the pectoral muscle can affect the results of intensity based image processing methods in the detection of breast densities (Velayutham and Thangavel, 2012).

1.6 Problem Statement

Mammography has major problems due to high breast density, which obscures the mammographic image. The main drawback of mammography today is that it is hard to differentiate between normal, dense tissue and cancerous tissue when looking for small tumors surrounded by glandular tissues. The accurate mammography depends on the degree of image clarity and lack of noise. All the image processing techniques used for enhancing mammography contrast and noise removal achieved the ambition of researchers but did not achieve optimal results. The research aims to use image processing techniques to improve the image quality by removing the noise and improving the image contrast (Naseem et al., 2012).

1.7 Research Aim

This research investigates the use of image processing techniques for enhancing mammographic images quality in order to help radiologists in taking the right decision in the process of early diagnosis of breast cancer.

1.8 Objectives

The main objectives of this research are to enhance the breast cancer detection as a variation from normal appearance using following techniques:

i. To improve the image denoising base median and wiener filters thereby removing the noise in the mammogram images.
ii. To enhance the mammogram images by the use of the contras limited adaptive histogram equalization (CLAHE).

1.9 Research Significance

Breast cancer recently is the most popular cancer among women worldwide. Mammography has been the most dependable and efficient screening measure for breast cancer early detection. Mammography suffers from a big problem, which is the difficulty of differentiating between tumor tissue and normal ones in high efficiency that leads sometimes to an error in the diagnostic process and often causes of cancer death among women worldwide. This research aims to remove the noise that increases the image blurry, and enhances its quality to consolidate the cancer diagnostic process.

1.10 Scope of Research

This research focuses on noise removing and image enhancement to increase the mammography quality to improve early breast cancer detection. Two stage of filtering include median and wiener filters will be used for noise removal because they can perform better than single techniques. Contrast Limited Adaptive Histogram Equalization (CLAHE) will be used to enhance the image contrast. The Mammographic Institute Society Analysis (MIAS) database will be used in this research according to the various cases it includes (Eltoukhy et al., 2009).

1.11 Thesis Organization

This research will be organized in five chapters as follows:

Chapter 1 describes the introduction and background of the study, problem statement, objectives, scope and significance of the study.

Chapter 2 reviews the literature on breast cancer.

Chapter 3 describes the research methodology is explained in chapter 3, which covers the research procedure, data and proposed technique.

Chapter 4 describes the results obtained in this work as stated in the objective of the research.

Finally, chapter 5 concludes the results and discussions. The recommendation and suggestions about the future works are also provided.

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