Computer Aided Detection System for Micro-calcifications in Digital Mammograms

By

Eng. Hayah Mohamed Bedear

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE

In

SYSTEMS AND BIOMEDICAL DEPARTMENT

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Under the Supervision of

Prof. Dr. Amr Sharawy

……

Professor of Syatem &Biomedical Engineering

System & Biomedical Department
Faculty of Engineering, Cairo University

Prof. Mai S. Mabrok

……

Ass. Professor and Department head
Biomedical engineering Department

System & Biomedical Department
Faculty of Engineering, Must University

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Approved by the

_____

Prof. Dr. Amr Sharawy, Thesis Main Advisor

_____

Dr. Mai S. Mabrouk, Thesis Supervisor

_____

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Table of Contents

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List of Figures

List of Tables

List of Abbreviations

DCIS: Ductal Carcinoma In Situ

LCIS: lobular carcinoma in situ

MRI: Magnetic resonance imaging

IBC: Inflammatory breast carcinoma

HRT: Hormone replacement therapy

BRCA: Breat Cancer

CC: Cranial-Caudal

MLO: Medio-Lateral Oblique

LM: lateromedial

ML: Mediolateral view

FFDM: Full-field digital mammography

SFM: Screen film mammography

DICOM: Digital Image Computer Mammography

AEC: Automatic exposure control

MIAS: Mammographic image analysis society

ALOE: Local edge orientation histogram

DOG: Difference of Gaussian

FN: False Negatives

FP: False Positives

TP: True Positive

TN: True Negative

ROI: Regions of Interest

MCCS: Micro Calcifications

CADe: Computer Aided Detection

CADx: Computer Aided Diagnosis

FCC: Fibrocystic Changes

ACR: American Cancer Radiology

FSHS: Full Scale Histogram Stretching

GHE: Grayscale histogram equalization

HE: Histogram Equalization

GLCM: Gray Level Co-occurrence Matrix

ANN: Artificial Neural Network

KNN: K-Nearest Neighbor

SVM: Support Vector Machine

NCI: National Cancer Institute

MLP: Multi Layer Perceptron

Before

Abstract

Breast cancer is the uncontrolled growth of abnormal cells in the breast, continues to be a significant public health problem in the world and the second leading cause of cancer death, following lung cancer. Micro calcification clusters (MCCs) and masses are the two most important signs for the breast cancer, and their automated detection is very valuable for early breast cancer diagnosis. Early detection is the key for improving breast cancer prognosis.

Among U.S. women, breast cancer is the most commonly diagnosed cancer and the second leading cause of cancer death, following lung cancer. About 10% of the approximately 8.25 million Dutch women have to face breast cancer. Every year there are around 11,000 newly diagnosed breast cancer patients. Men account for less than 1% of the diagnosed breast cancers. 25% of the newly diagnosed patients are detected by the breast cancer screening programe. The five year survival rate can be increased from 60% to 82% by an early diagnosis of breast cancer. The breast cancer screening program is offered to women aged 50-75 and about 76% of the women take part. The mammography screening takes place every 2 years. 100 of the 10,000 mammographically screened women are recalled for additional assessment. So, during the last years, screening programs became essential step for women over 40 years old. Therefore, physicians have to examine a huge number of images leading to 10-30% of missed breast lesions.

Mammogram breast X-ray is considered the most reliable method in early detection of breast cancer and the single most effective, low-cost, and highly sensitive technique for detecting small lesions. However, the sensitivity of mammography is highly challenged by the presence of dense breast parenchyma, which deteriorates both detection and characterization tasks. As the consequences of errors in detection or classification are costly and since mammography alone cannot prove that a suspicious area is timorous malignant or benign, the tissue has to be removed for closer examination using breast biopsy techniques.

Thus, Image processing techniques have been developed methods for automatic detection and classification of suspicious areas in mammograms, as a means of aiding radiologists to improve the efficacy of screening programs and avoid unnecessary biopsies. Computer aided tools have been shown to be powerful systems to overcome this problem;

the reader's sensitivity can be increased by an average of 10% with the assistance of CAD systems.

The main goal of this thesis is to develop a Computer Aided Diagnosis (CAD) system based on supervised classification that can be very helpful for radiologist in diagnosing and detecting the specific abnormalities breast cancers' patterns (mass and micro calcification) in digitized mammograms earlier and faster than typical screening programs, and improving the diagnostic accuracy in making the diagnostic decisions by applying techniques splits into steps procedure beginning with preprocessing step using the best image enhancement techniques by using Full Scale Histogram Stretching (FSHS), Histogram Equalization (HE), Morphological Enhancement and Wavelet Transform to improve the quality of the image to make it ready to further processing by removing the unrelated and surplus parts in the back ground of the mammogram in order to improve the image quality and make the segmentation results more accurate, followed by segmentation based on Otsu's threshold the region of interest for the identification of micro calcifications and mass lesions. Different features type geometric, chromatic and texture features are extracted from the region of interest resulted from segmentation using Moment Invariant, Shape Features and Gray Level Co-occurrences Matrix Features. Then, the most prominent features that can cause an effect are selected by the Fisher score method. Selected features are fed into three different classifies, which classify between normal and micro-calcifications 'patterns and then classify between benign and malignant micro- calcifications. In classification stage; three methods were used, the voting K-Nearest Neighbor classifier (K-NN) with prediction accuracy of 80%, Support Vector Machine classifier (SVM) with prediction accuracy of 83%, and Artificial Neural Network classifier(ANN) with prediction accuracy of 96%.

Chapter 1

Introduction

1.1 Introduction

Breast cancer is the most common cancer and continues to be a significant public health problem among women around the world [1], and is the second leading cause of female cancer mortality after lung cancer [2]. There are different types of breast cancer, with different stages (spread), aggressiveness, and genetic makeup. With best treatment, 10-year disease-free survival varies from 98% to 10%. Treatment includes surgery, drugs (hormone therapy and chemotherapy), and radiation. According to the World Health Organization, more than 1.2 million people worldwide will learn they have breast cancer this year. The American Cancer Society estimates women in the United States will account for approximately 213,000 of these cases. The National Cancer Institute (NCI) reports breast cancer as the most common type of cancer among women in the US.

Statistics have shown that 1 out of 10 women are affected by breast cancer in their lifetime. An estimated 1.38 million women across the world were diagnosed with breast cancer in 2008, accounting for nearly a quarter (23%) of all cancers diagnosed in women. It is also the most common cause of death from cancer in women worldwide, estimated to be responsible for almost 460,000 deaths in 2008[3]. According to the American Cancer Society in 2009, approximately 269,800 cancer deaths in women and the breast cancer reaches to 15% from it. The diagnosed cancer cases were 713,220 and the breast cancer occupied 27% of these cases, and estimates that in 2011[4] approximately 230,480 women in the US diagnosed with tumor breast cancer, and about 39,520 women died from breast cancer. In 2013, an estimated 232,340 new cases of invasive breast cancer and 39,620 breast cancer deaths are expected to occur among U.S. women [5]. Cancer statistics claim that breast cancer got the third position of appearance in diagnosed new cases following genital organs and digestive systems cancer comparing to other forms of cancer [6]. Figure 1.1 shows death rates due to breast cancer in comparison to other types of cancer over the last seven decades. Early detection and diagnosis of breast cancer plays a very important role in cancer treatment and allows a faster recovery for most of the patients, and considered the most effective methods of reducing mortality [7,8].