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Automatic Classification of Breast Tumors Using Features Extracted from Magnetic Resonance Images

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Abstract

Breast cancer is considered as the second leading cause of cancer deaths among women in the United States. Early detection of cancer is crucial in order to reduce its negative effects. Recently, magnetic resonance imaging (MRI) has become an important modality in the detection of breast cancer in daily practice. However, routine breast MRI has a moderate specificity that may increase its false positive rates. Therefore, automated detection techniques of malignancy can provide an important tool for clinicians. In this study, different data classification methods were examined to classify breast tumors screened using contrast enhanced MRI. The used data set included 20 subjects categorized clinically into two groups; benign and malignant tumors. MRI scans were first preprocessed to extract imaging features. Then two classification methods were exploited to differentiate between the two tumor's categories using the extracted features. The used classification methods were K-Nearest Neighbor (KNN), and Linear Discriminant Analysis (LDA). The results show a relatively significant classification accuracy compared with pathological analysis, and also the calculated resubstitution error. In summary, the proposed automatic classification techniques can be used as noninvasive diagnostic tools for breast cancer, with the capability of decreasing false positive errors associated with regular MRI diagnosis.

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Keywords: *Data classification; Feature Extraction; K-Nearest Neighbour; Linear Discriminant Analysis; Magnetic Resonance Imaging; Breast Cancer.*

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1. Introduction

Globally, breast cancer involves about 23% of all cancer types in women. This type of cancer caused about 460,000 deaths worldwide, which resembles 13.7% of female deaths caused by cancer [1]. Following lung cancer, breast cancer is considered to be the second leading cause of cancer deaths among women, according to a recent statistics in the United States [2]. Mammography imaging followed by pathological diagnosis through biopsy are currently the routine methods for imaging and diagnosing suspected breast tumors. The sensitivity of mammography breast cancer detection generally is high [3], however, when imaging females with dense breasts, the sensitivity degrades to near 62% [4]. Biopsy is considered the gold diagnosis standard, and it is routinely performed under conventional US guidance; yet, about three quarters of the performed biopsies yield a benign diagnosis [5]. The biopsy procedure is invasive, costly and causes stress for the patient. In order to reduce its necessity, other imaging modalities was proposed, such as ultrasound elastography and magnetic resonance imaging (MRI) [6, 7]. Therefore, early malignancy diagnosis is crucial to avoid tumor metastasis and elevate the survival rate of diseased patients.

Lately, MRI has become an important and useful imaging modality in the visualization and detection of breast tumors in daily practice. However, MRI breast imaging has a relatively moderate specificity rate that increases its false positive percentages[8, 9]. If MRI is used for routine examination, diagnosis of specific types of cancer would have a significantly higher sensitivity rates and at an earlier cancer stage.[10] One of the main MRI imaging analysis methods is histogram analysis that usually used to identify the different morphological and anatomical regions [11]. some studies used this method to describe the relation between histogram parameters and the tumors physiological changes to achieve an improved exploitation of these parameters as substitutive and representative markers of tumor's heterogeneity[9, 12]. The past decade incorporated a number of studies that exploited histogram approaches with an increasing focus on various MRI techniques and imaging sequences, although information related to the tumor's heterogeneity remains not fully understood [9].

In this study, tumor heterogeneity was investigated through calculation of ten histogram parameters to differentiate between the two major breast tumor classes; benign and malignant. The histogram parameters were extracted from the participant's MRI imaging data and used as the tumor's imaging and characterizing features. Two classification methods were then used to classify the acquired data. Following that, the classification accuracy was determined by comparing the outcomes with pathologically validated tumor diagnosis, and consequently the resubstitution error was calculated.

Throughout this paper, we will demonstrate that the proposed automatic classification techniques have the potential as a noninvasive characterization tools for breast masses. This may lead to reducing the necessity to perform biopsy in order to determine the benignancy or malignancy of breast tumors.

2. Methods

A number of 20 participating patients with suspected breast masses were included in this study. The data were acquired from three different health care faculties. Patients' ages ranged from 32 to 70 years. Table 1 lists the number of masses involved in the study, along with their pathologic diagnosis.

Contrast enhanced MRI imaging were performed for all patients, which is a routine procedure that aims at highlighting the breast tumors structure, morphology and facilitates visualization of lesion heterogeneity. Contrast enhanced MRI is commenced by injecting a contrast agent into the patients circulatory system, so that this agent will reach the tumor and accumulate with a rate that is dependent on the tumor's type. The pathological method; Biopsy, is considered as the gold standard, was performed for all patients. An informed consent was received from each participant prior performing any analysis on the acquired MRI imaging data.

Table 1. Pathologic diagnosis of the examined patients

Breast Mass Type	Pathologic Diagnosis
Benign (10)	Fibroadenoma (6)
	Fibrocystic Change (2)
	Cystic Lesion (2)
Malignant (10)	Invasive Ductal Carcinoma (IDC) (10)