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A system of microcalcifications detection and evaluation of the radiologist: comparative study of the three main races in Malaysia

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Abstract

This paper uses wavelets in the detection comparison of breast cancer among the three main races in Malaysia: Chinese, Malays, and Indians followed by a system that evaluates the radiologist's findings over a period of time to gauge the radiologist's skills in confirming breast cancer cases. The db4 wavelet has been utilized to detect microcalcifications in mammogram-digitized images obtained from Malaysian women sample. The wavelet filter's detection evaluation was done by visual inspection by an expert radiologist to confirm the detection results of those pixels that corresponded to microcalcifications. Detection was counted if the wavelet-detected pixels corresponded to the radiologist's identified microcalcification pixels. After the radiologist's detection confirmation a new client–server radiologist recording and evaluation system is designed to evaluate the findings of the radiologist over some period of cancer detection working time. It is a system that records the findings of the Malaysian radiologist for the presence of breast cancer in Malaysian patients and provides a way of registering the progress of detecting breast cancer of the radiologist by tracking certain metric values such as the sensitivity, specificity, and receiver operator curve (ROC). The initial findings suggest that no single race mammograms are easier for wavelets' detections of microcalcifications and for the radiologist confirmation even though for this study the Chinese race samples detection average were a few percentages less than the other two races, namely the Malay and Indian races.

Keywords: Microcalcifications; Cancer; Wavelets; Radiologist; Mammogram

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1. Introduction

Breast cancer is one of the most common cancers for women in many countries and Malaysia is no exception. Women across the world have variations in breast cancer tissue cells depending on their body size, diet, reproductive characteristics such as age of menarche, number of children, and age of menopause and existence rates vary from one race to another. For example, white women were found to have higher rates of breast cancer than the incidence of breast cancer in black women [1]. In Malaysia a similar study carried out by University Malay Medical Center in Kuala Lumpur (HUKL) in the year 2000 has shown that 60% of 952 cancer patients admitted to the UHKL in the years 1993–2000 were Chinese patients. It was concluded that the incidence of breast cancer in the Chinese appears to be higher than the other two races, namely Malays and Indians. Also according to the 1996 report of the Penang Cancer Registry in Malaysia, the estimated occurrence of breast cancer in Malaysia was 27 per 100 thousand population with 2700 cases each year. Breast cancer was seen to affect mainly women of ages 45–64 years, and is appeared to be predominant among Chinese women with 28 cases per 100 thousand population followed by 25 cases per 100 thousand population and 16 Malay cases per 100 thousand population. The current radiologist detection tool of breast cancer is through mammography.

In a mammogram image, radiologists try to distinguish normal from cancerous tissue by looking at the shape and density of an abnormal mass in a tissue area. Usually, the malignant area is characterized by indistinct border-shapes. For early detection, radiologists try to identify microcalcifications, usually clustered ones as indicators of cancer (malignant). These clusters usually appear with very sharp edges, irregular shapes, and in very small sizes and they are believed to be the first signs of breast cancer. The microcalcifications are normally known to be of size range 0.1–1 mm isolated or clustered pixels that constitute the first warning signs for breast cancer [2].

Radiologically some difficulties arise when interpreting mammograms because the mammograms are images of high resolution and low contrast and they also have a great variation in their gray scales. In some mammograms the calcifications are seen as white spots on a dark gray background, while in other mammograms they are visible as brighter gray spots on a slightly darker gray background. There may also be other bright regions not associated with calcifications. Therefore, in mammography the contrast between the whole soft tissues of the breast is minimal and small change in the breast tissue structure can mean malignant breast tumor [3]. Therefore, many researchers have taken the task of finding ways to help the radiologist with manual and automatic computer aids. One useful detection tool is through wavelets.

Wavelets can be a good tool for medical image enhancement that perform enhancement by amplification or some modification to wavelet coefficients prior to reconstruction. Wavelets, as a mathematical tool, have found many applications in signal processing, image processing, image compression, etc. in the past few years. As is well known wavelets came to replace the Fourier transform because they localize the information both in time and frequency unlike the Fourier transform which gives the frequency information of the 1D or 2D signals (images) [4].

2. Detection with wavelets

The wavelet transform is a decomposition of a signal with respect to a real orthonormal basis of functions, $\psi_{j,k}(t)$ obtained by translations and dilations of a single mother wavelet $\psi(t)$. The mother