A Filter-Based Approach Towards Automatic Detection of Microcalcification

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Abstract. To establish a practical CAD (Computer-Aided Diagnosis) system to facilitate the diagnosis of microcalcifications, we propose a filter-based technique to detect microcalcifications. Via examination of an existing optimal filter-based technique, it is found that its performance on highlighting the energy of mammograms is seriously affected by artefacts and the background of breast. As a result, four methods in pre and post-processing are described in this paper to improve the optimal filtering, leading to an adaptive selection of thresholds for input mammograms. These methods have been tested by using 30 mammograms (with 25 microcalcifications) from the MIAS database and 23 mammograms from DDSM database. Comparing with the original optimal filter-based technique, our technique reduces the false detections (FD), eliminates the influence of the background in mammograms and is able to adaptively select the threshold for the detection of microcalcifications.

1 Introduction

Breast cancer is one of the major causes of deaths among women in developed countries and early detection is the most effective way to reduce mortality. Mammography (X-ray examination of the breasts) is currently the most efficient and widely adopted method for early detection. Since abnormalities might be a tiny part of a whole mammogram and could be camouflaged by various densities of breast tissue structures, the interpretation of mammograms is a delicate and time-consuming task, and the performance of the observer could be dramatically degraded by large numbers of mammograms.

Clustered microcalcifications are one of the early indicators of potential cancerous changes in breast tissue. A microcalcification is a small calcium deposit that has accumulated in breast tissue, and it appears as a small bright and blurred spot on the mammogram. Typically, individual microcalcification ranges in size from 0.1-1.0 mm, which could be overlooked by an examining radiologist.

Some commercial CADs have been developed to help radiologists in diagnosis. According to recent researches on some typical commercial systems, they could achieve a True Positive (TP) rate of 85%-87% with a False Positive (FP) rate of about 0.2 detections per image for a single view [1], [2]. However, some researches [3] show the sensitivity of the commercial system may need further improvement

Susan M. Astley et al. (Eds.): IWDM 2006, LNCS 4046, pp. 424 – 432, 2006.

according to their experiments. Our experience of using an existing commercial CAD system is similar: too many prompts were activated every time a mammogram is being read in testing the system. In order to further improve TP rates and reduce FP rates, we are developing a microcalcification detection system, which adopts a latest optimal filter-based detection technique. In this paper, a technique composed of several new pre- and post-processing methods is proposed to address the issues of applying the optimal filter-based technique to more practical utilization and facilitate to apply data mining techniques for further classification.

The optimal filter-based technique [4], [5] is a texture feature extraction scheme. It extracts local frequencies in the mammogram where one of the textures has low signal energy and the other texture has high, and its filter is optimised with respect to the Fisher criterion. Reported results show a TP rate of 100%, with a 1.5 FP clusters per image [5], [6]. Different from other filters such as LoG (Laplacian-of-a-Gaussian) filter [7], [8], the optimal filter-based technique is based on the texture features: feature mean and variance.

This paper is organised as follows. The new pre- and post-processing methods are proposed in Sect. 2 and our experiment results are provided in Sect. 3. Discussion on the results and our future plan are presented in Sect. 4.

2 New Pre-processing and Post-processing Methods

Roughly speaking, a microcalcification detection system usually consists of two main procedures: microcalcification enhancement and microcalcification classification. In the first procedure, the signals that represent possible microcalcifications are enhanced and the signals that represent the normal tissue are suppressed. A threshold is applied to processed mammograms to segment the signals of possible microcalcifications from those of normal tissue. In the second procedure, the features of the possible microcalcifications are extracted, and trained by using different data mining technologies such as neural network [9] and SVM [10] to decide the property of the suspicious regions: normal, begin or cancer. Our new methods are proposed to improve the result of the first procedure and their relationships with the optimal filter-based technique are shown in Fig. 1.

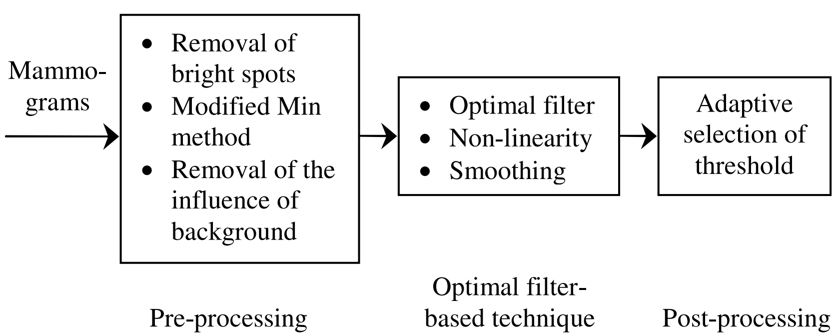

Fig. 1. Relationships between four new methods (3 methods for pre-processing and 1 for post-processing) and the optimal filter-based technique