Chapter 2.5

Computer Aided Risk Estimation of Breast Cancer:
The "Hippocrates–mst" Project

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ABSTRACT

In this chapter the authors report about their experiences in designing, implementing, prototyping and evaluating a system for computer aided risk estimation of breast cancer. The strategy and architecture of "Hippocrates-mst" along with its functionalities are going to be presented. Also, the evaluation results in the clinical practice concerning the performance of "Hippocrates-mst" in the "Ippokrateio" University Hospital of Athens will be presented. The feedback from medical experts along with the new features of the system that are under development will be discussed.

INTRODUCTION

Breast cancer is worldwide the most frequent cancer in women. Years of experience have revealed that mammography constitutes the most efficient method in the early diagnosis of this type of cancer (Elmore et al., 2005). Clustered microcalcifications belong to the worthy mammographic findings since they have been considered as important indicators of the presence of breast cancer (Fondrinier et al., 2002, Gulsun et al., 2003, Buchbinder et al., 2002, Bassett, 1992). Several efforts have been made to classify the microcalcifications as benign or malignant according to their characteristics (Lanyi, 1977, 1985, Le Gal et al., 1984, 1976, Timins, 2005). However, problems

still appear in mammographic imaging methods due to subtle differences in contrast between benign and malignant lesions, mammographic noise, the insufficient resolution and local low contrast. These inherent difficulties of mammographic image reading prevent the medical expert from quantifying the findings and from making a correct diagnosis (Wright et al., 2003, Shah et al., 2003, Yankaskas et al., 2001, Elmore et al., 2003). Therefore, a non-negligible percentage of biopsies following mammographic examination are classified as false positive (Esserman et al., 2002, Roque & Andre 2002).

Improvements towards the early diagnosis of breast cancer, as far as the computer science is concerned, belong to the field of systems for computer-aided mammography (Doi et al., 1997, Wu et al., 1992). Such systems have mainly dealt with detection and classification of microcalcifications and use image processing and analysis techniques as well as artificial intelligence methods. The most well known methods of computer aided detection or diagnosis in mammography are artificial neural networks (ANN) with different architectures and variations, the segmentation methods, multiscale analysis - wavelets and morphologic analysis to distinguish between malignant and benign cases (Wu et al., 1993, Zhang et al., 1994, Chan et al., 1995, Zhang et al., 1996, Gurcan et al., 2001, Gurcan et al., 2002, Cooley & Micheli-Tzanakou, 1998, Bocchi et al., 2004, Dengler et al., 1993, Gavrielides et al., 2002, Li et al., 1997, Zhang et al., 1998, Lado et al., 2001, Mata Campos et al., 2000, Shen et al., 1994, Chang, et al., 1998, Spyrou et al., 1999).

The project that we present here, describes a system that deals with the digital or the digitized mammographic image, offering computer aided risk assessment starting from a selected region with microcalcifications (Spyrou et al., 1999, Spyrou et al., 2002a, 2002b). The proposed system is based on methods of quantifying the critical features of microcalcifications and classifying them as well as their clusters according to their probability of being cancerous. A risk-index calculation model has been developed and is included in the system. Furthermore, the calculated risk-index can be refined through other information such as the position and the direction of the cluster along with information from the patient record such as the age and the medical history of the patient (Berg et al., 2002, Cancer Facts and Figures, 2004). The design of the interface follows the clinical routine and allows for interaction with the physician at any time, providing information about the procedures and parameters used in the model of diagnosis.

Apart from the very encouraging laboratory testing, the prototype system is under a long-term evaluation phase in "Ippokrateio" University Hospital of Athens. Up to now the results from the current evaluation procedures indicate that the system estimates the risk of breast cancer towards the right direction. As far as the malignant cases are concerned, the system has a very high sensitivity. For the benign cases, the system is able to achieve a significant reduction on the unnecessary biopsies. Nevertheless, the sensitivity and specificity levels are not balanced. Actually, there is an overestimation of risk driven from the attempt to minimize the false negative results. Therefore, we further investigate for a better compromise which will emerge after a fine tuning in the calculation of parameters and the setup of thresholds concerning the selected features of the microcalcifications and their clusters.

SYSTEM AND PROGRAM DESCRIPTION

The method used in this computer aided risk assessment scheme is outlined in Figure 1. According to this scheme, the doctor may select from the patient's archive the set of the four mammographic images (Right and Left CranioCaudal-CC and MedioLateral-ML) that corresponds to a specific date of mammographic examination. Every selected image from this set can be displayed

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