

Chapter 39

Statistical Analysis for Radiologists' Interpretations Variability in Mammograms

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ABSTRACT

Conventional mammography is considered the modality of choice for the detection of breast cancer. The process involves a human radiologist visually diagnosing the mammogram, which causes limitations such as missing a cancer and/or diagnosing a false cancer. Another disadvantage of conventional mammography is the variability among screening radiologists in interpreting mammographic images. The objectives of this study are to verify this variability and to develop an image processing algorithm that can automatically detect benign tumors of the female breast. A sample of ten digital mammograms obtained from the MiniMIAS database was distributed to four different radiologists in order to verify the variability among them. Furthermore, three algorithms were developed in order to automatically detect benign tumors of the female breast. The proposed algorithms were based on combinations of certain statistical features and were tested on the same sample of images. Results showed that the detection mechanism using the proposed algorithms was acceptable despite the fact that they exhibited a few errors. It was concluded that the use of a combination of the mean and median statistical tools is effective in assisting radiologists in interpreting mammographic images containing benign tumors.

INTRODUCTION

Breast cancer continues to be a significant public health problem in the world. Worldwide, it comprises 22.9% of all cancers in women (Boyle & Levin, 2008). Approximately, 182,000 new cases

of breast cancer are diagnosed and 46,000 women die of breast cancer each year in the United States. Although significant efforts are made to achieve early detection and effective treatment but scientists do not know the exact causes of most breast cancer, they do know some of the risk factors (i.e. ageing, genetic risk factors, family history, menstrual periods, not having children, obesity)

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that increase the likelihood of developing breast cancer in females. Breast cancer is a disease of uncontrolled breast cells growth, in which the cells acquire genetic alteration that allows them to multiply and grow outside the context of normal tissue development (Locasale & Cantley, 2010). The cell metabolism increases to meet the requirements of rapid cell proliferation, autonomous cell growth and to maintain its survival (Locasale & Cantley, 2010). The most common symptom of breast cancer is the presence of painless and slowly growth lump that may alter the contour or size of the breast. It is also characterized by skin changes, inverted nipple and bloodstained nipple discharge (Zou & Guo, 2003). The lymphatic nodes under the armpit may be swollen if affected by cancer. In late stage, the growth may ulcerate through the skin and infected (Zou & Guo, 2003). Bone pain, tenderness over the liver, headaches, shortness of breath and chronic cough may be an indication of the cancer spreading to other organs in the body. Early diagnosis requires an accurate and reliable diagnosis procedure that allows physicians to distinguish benign breast tumors from malignant ones without going for surgical biopsy (Cheng et al., 2003). Mammography is a specific type of imaging that uses a low-dose X-ray system to examine breasts. The dose is typically known to be around 0.7 mSv. Mammography plays a central part in early detection of breast cancers because it can show changes in the breast up to two years before a patient or physician can feel them. The detection process is based on the identification of areas of high intensities that indicate the presence of either benign or malignant tumors. Two types of mammography are known; Screen-Film Mammography (SFM) and Digital Mammography (DM). DM was introduced as an alternative diagnostic technique in order to overcome the problems of SFM which include the variability of diagnosis among the screening radiologists as well as limitations in the detection of benign tumors (Hambly et al., 2009; Skaane, 2009; Skaane et

al., 2007; Van Ongeval et al., 2005). DM incorporates a new technique called Computer-Aided Diagnosis (CAD) which employs the tools of image processing for image enhancement and diagnosis (Balakumaran et al., 2010; Noble et al., 2009; Li et al., 2008; Doi, 2007; Zheng et al., 2004, 2002; Christoyianni et al., 2002; Doi et al., 1999). It takes an electronic image of the breast and stores it directly in a computer. DM uses less radiation than film mammography. The goal of CAD is to improve radiologists' performance by indicating the sites of potential abnormalities, to reduce the number of missed lesions, and/or providing quantitative analysis of specific regions in an image to improve diagnosis (Visser et al., 2012; Bick & Diekmann 2007; Bazzocchi et al., 2001). Computer-aided methods for detecting malignant texture have been achieved using different techniques (Oliver et al., 2010, 2006; Houssami et al., 2009; Elter & Horsch 2009; Kim et al., 2008; Yang et al., 2007; Sakka et al., 2006; Arodz et al., 2005; Mavroforakis et al., 2005; Sajda et al., 2002; Gavrielides et al., 2002; Li et al., 2002; Verma and Zakos 2001; Kobatake et al., 1999). CAD systems typically operate as automated "second opinion" or "double reading" systems that indicate lesion location and/or type. Since individual human observers overlook different findings, it has been shown that "double reading" increases the detection rate of breast cancers by 5%-15% (Bazzocchi et al., 2001).

Subjectivity among screening radiologists in the interpretation of mammograms results in a high percentage of misdiagnosed cancer cases and a high percentage of missed cancer cases (Cornford et al., 2011, 2005; Halladay et al., 2010; Molins et al., 2008; Gur et al., 2008; Elmore et al., 2009, 2003, 1998, 1994; Coldman et al., 2006; Beam et al., 1996, 2003; Moss et al., 2005; Blanks et al., 1998). This subjectivity is the end product of several factors including radiologists' fatigue, incompetence and lack of training to name a few. The ultimate diagnosis of all types of breast disease

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