Image processing can cause some malignant soft-tissue lesions to be missed in digital mammography images


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AIM: To investigate the effect of image processing on cancer detection in mammography.

METHODS AND MATERIALS: An observer study was performed using 349 digital mammography images of women with normal breasts, calcification clusters, or soft-tissue lesions including 191 subtle cancers. Images underwent two types of processing: FlavourA (standard) and FlavourB (added enhancement). Six observers located features in the breast they suspected to be cancerous (4,188 observations). Data were analysed using jackknife alternative free-response receiver operating characteristic (JAFROC) analysis. Characteristics of the cancers detected with each image processing type were investigated.

RESULTS: For calcifications, the JAFROC figure of merit (FOM) was equal to 0.86 for both types of image processing. For soft-tissue lesions, the JAFROC FOM were better for FlavourA (0.81) than FlavourB (0.78); this difference was significant (p=0.001). Using FlavourA a greater number of cancers of all grades and sizes were detected than with FlavourB. FlavourA improved soft-tissue lesion detection in denser breasts (p=0.04 when volumetric density was over 7.5%).

CONCLUSIONS: The detection of malignant soft-tissue lesions (which were primarily invasive) was significantly better with FlavourA than FlavourB image processing. This is despite FlavourB having a higher contrast appearance often preferred by radiologists. It is important that clinical choice of image processing is based on objective measures.

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Introduction

The optimal way to process mammography images to improve the detection of breast cancer is uncertain. Image-processing techniques include greyscale transform, unsharp masking, multiscale image enhancement, and peripheral enhancement. The greyscale transform aims to ensure that the parts of the image with the highest diagnostic information content are displayed with optimal contrast, whereas other parts that are less relevant have a lower contrast. Unsharp masking aims to sharpen images by using a blurred mask of the original image. It is most often used to enhance high frequencies in an image. Multi-scale image enhancement allows for features at different frequencies to be enhanced differently. Peripheral enhancement compensates for the reduction in tissue thickness at the edge of the breast.

There have been a few studies investigating the effect of image processing on cancer detection. Some found that change in image processing caused a significant difference in cancer detection, whereas others found no significant difference. The aim of the present study was to investigate the effect on cancer detection of two types of image processing that have required a much wider investigation with control of objective to optimise the image processing, which would be enhanced differently. Peripheral enhancement compensates for the reduction in tissue thickness at the edge of the breast.

The cases used in the present study were selected from a database of unprocessed mammography images collected locally. At the time of the study, the database contained unprocessed mammography images collected from 1,624 women attending a UK NHS breast screening programme (NHSBSP) centre, imaged between March 2011 and June 2014 on Hologic Selenia and Hologic Dimensions systems (Hologic, Bedford, MA, USA). A database of Siemens images was not available.

In the present study, the cancers included only women with subtle or very subtle signs of breast cancer on the mammograms. The number of cancers with a subtle or very subtle appearance required in the study was based on the results of a pilot study, using power calculations performed using jackknife alternative free-response receiver operating characteristic (JAFROC) software (JAFROC, version 4.0, D.P. Chakraborty; http://www.devchakraborty.com/). It was found that 83 cases containing subtle calcification clusters and 86 soft-tissue lesions were required for 80% power and an effect size of 0.01. The effect sizes used in the power calculations were based on effect sizes found in the pilot study. Twenty-two of the 169 (83%) abnormal cases included multiple cancers; therefore, there were 92 calcification clusters and 99 soft-tissue lesions in the 169 abnormal images. In addition to the cases with cancer, 35 women were randomly selected from those with biopsy-proven benign lesions and 145 women were randomly selected from those with normal images.

When the study began, the women whose images were “normal” had not yet returned for their next 3-yearly breast screening examination. Subsequently, 110 of these women attended their next screening examination and all were again read as normal, the remaining 35 women did not re-attend 3 years later at the same centre; however, they have not presented with interval cancers.

The examination consisted of two views of each breast, a craniocaudal (CC) view and a mediolateral oblique view (MLO). In this study, all four breast images were used. The volumetric breast density measured with Volpara (Volpara Solutions, Wellington, New Zealand) varied from 3% to 46% (average of 10%). There was no significant difference between the average breast density measured on the images used in the study, and the average breast density measured on all images in the database (p=0.29).

Materials and methods

The methodology comprises four parts: (1) case selection for the observer study, (2) image processing, (3) study protocol, and (4) statistical analysis. The study protocol was approved by the national research ethics committee as part of the OPTIMAM research programme.
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